LECTURES

ON

ANIMAL PHYSIOLOGY;

OR THE

PHYSICAL CONDITION OF MAN,

AS REGARDS

LIFE, HEALTH, AND DISEASE:

DELIVERED AT

THE NORWICH MECHANICS' INSTITUTION,

SEPTEMBER, 1841,

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OF ST. BARTHOLOMEW'S MEDICAL SCHOOL, LONDON.

WITH SIX PLATES.

"O LORD WHAT IS MAN THAT THOU ART MINDFUL OF HIM? OR THE SON OF MAN THAT THOU VISITEST HIM?

"THOU HAST MADE HIM A LITTLE LOWER THAN THE ANGELS, AND CROWNED HIM WITH GLORY AND HONOUR." PSALM VIII. 4, 5.

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PREFACE.

YIELDING to the request of many intelligent and hilosophical friends, and further encouraged by the arm wishes and support of a numerous audience, ıe author of the following lectures commits his book) the great ocean, to make one amongst the many essels of meditation already floating upon its waters. ıdependent and original in many of his ideas, striving) disclose the vast and sublime condition of man—IE IMMORTAL BEING—as he stands connected with ı outward organic material, he foresees the possibility ' opposition, perhaps a storm, gathering around his gh aimed efforts, from a cold and sensual philosophy ow common and powerful; but in the words and ntiment of the Poet, he finds courage and says,

"Go little book from this my solitude!
I cast thee on the waters—go thy ways!
And if, as I believe, thy vein be good,
The world will find thee after many days."

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ANIMAL PHYSIOLOGY.

LECTURE I.

INTRODUCTION TO THE STUDY OF PHYSIOLOGY.

PART 1. INTRODUCTION—PHYSIOLOGY IN ITS VAST AND SUBLIME NNECTIONS—MEANING OF THE TERM PHYSIOLOGY—PREJUDICES AINST ITS BECOMING A POPULAR STUDY—CONSEQUENCES OF IGNO-NCE—BLISS OF KNOWLEDGE—CAUTION ON COMMENCING THE STUDY PHYSIOLOGY—RULES FOR STUDYING PHILOSOPHY—THE GRANDEUR PHYSIOLOGY.

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iends and Members of the Mechanics' Institution.

In bringing the subject of Animal Physiology fore your notice in a single Lecture,* it is my intention, her to point out some of the principal and leading features nnected with that noble study, than to descend into its nuter particulars; for, interesting as even every nerve and

This lecture was delivered as complete in itself, announced as "An Introduction he Study of Physiology." The three succeeding lectures were afterwards written he request of the friends and members of the Mechanics' Institution.

fibre of the body may have become to the initiated eye, and useful as their contemplation may be in the previously educated mind, I am not to suppose interest and usefulness to lie with us in these minute and delicate investigations, at least not on our first meeting, or within the confines of an hour's discourse. Instead, therefore, I have chosen to point out the subject as it stands related to *the vast and the sublime*—unrivalled in the sciences, though it treats not of suns and systems like astronomy, and we may not be disposed to turn to microscopic observations with a Lewenhock or a Boerhaave. The view I purpose shewing, opens upwards and interiorily in following the thread of life into an infinity unknown in the profoundest space, and leads without, by a knowledge of corporeal function and act, into a series of harmonies and beauty, unrivalled by any less extensive field of inquiry, however accurate.

And how far am I able to take up this position? To discover the philosophy of a science like physiology, embracing the arcana both of nature and spirit? How far is any man capable of looking within and without *himself*, and telling the secrets of his being and existence, to any extent proportionate to the desire with which every enlightened mind pants after such information? I ask myself the question, and I hear others asking the same; and I feel the need of relying on your liberality, and my own conscious intention to draw from the subject information fitted for the purposes of improvement and use. Physiology, as a science, likened to the goddess Nature, holds within her bosom the most precious seeds the contemplative man can develope; and in this aspect I shall endeavour to present her to you this evening:—the perfect opposite of the figure we have alas too often seen, marred in her beauty, and stripped of her attire, and lauded by the falsely called "worshippers of reason."

Human corporeal existence, with all its functions and operations, regarding on the one hand, life, with its affection and thought, and on the other, an external world of beauty, almost inexpressible, is the definition of my subject already announced as animal physiology. Physiology, as a term, has been used with various significations. Its primary meaning is the study of physics or nature; but by custom we use it

exclusively to signify the study of animal or vegetable bodies; and thus we speak of *animal* physiology, and *vegetable* physiology. Human *animal* physiology is our present subject, that is, the study of the nature of the human body. The meaning of the term physiology is also still further restricted in professional language, where it is used merely to signify the function or mode of action usually performed by the corporeal organs; the term anatomy, being used to define the structure of such organs, and pathology, their diseased condition. Under the title of physiology, I include all we may have to say concerning our corporeal bodies. It is our shortest way of setting forth the subject, and just as correctly used in this more extended sense, as with its professional limitations, for, strictly speaking, physiology means, as I before stated, the study of nature.

I could stay here on the threshold of our discourse, a long time to expatiate on the usefulness and importance of this study; but I think such delay unnecessary when I regard the enlightened audience I have the pleasure to address. Yet we must not pass over wholly unnoticed, the prejudices we still find rampant against it, in common with almost all intellectual pursuits, pointed at so often with a sneer as "the march of intellect." It is not uncommon to hear the scoff or earnest imprecation directed against a popular and general study of physiology, in defence of which therefore, a few words at least must be spoken.

There is a prejudice with the ignorant, to believe themselves better off in their ignorance than they could possibly be if enlightened: for, they say, knowledge brings its cares and troubles. And selfish and interested men have not been found wanting, to work upon this feeling to the uttermost. We have been told that physiological knowledge will make us full of fears, and nervous fancies, and destroy the comfort of our lives, in short that we are better without it. The truth is exactly the reverse. It is ignorance that fills us full of fears and nervous fancies, and robs us of the bliss of life. "A little knowledge is a dangerous thing," cry the advocates of national barbarianism. And a little knowledge may perhaps be dangerous, but not near so dangerous as none at all. A little knowledge may perhaps be dangerous, if so, increase the knowledge, and so evade the danger. A

little knowledge is only dangerous, because it is so near to no knowledge, where all the danger lies concentrated, not the less deadly because hidden and unknown.

Another instance of the prejudices which have been invoked against our subject, I feel it necessary to allude to for a moment; namely, the prejudices which many entertain against woman's studying physiology; persuading her that she ought to blush at the bare thought of doing so. What, I would ask, blush to know the mighty works of her Creator! Sin, evil, and the false, alone ought to call up a blush, and that on the cheeks of all alike. Has not woman her children to educate, and ought she to be in ignorance? Let her remember it is our lot to live in a world of deep responsibility. Evil surrounds us as well as good. We none of us can go through life without experiencing the influences of both. There might have been a time when man was educated only into the good. Now it is otherwise. And nothing now can save us whole and entire but knowledge. As woman values her own, and her children's safety, she must attend to the study of physiology.

Need I detail the consequences of ignorance, or the bliss of knowledge, in furtherance of our desire to render physiology a popular science? A short, but striking picture, I have at hand, which, I conceive, must confirm all in our views of the necessity of general education. Take Paris, during the cholera of 1832, as an example of physiological ignorance. A rumour spread in this capital of Europe that the fountains were poisoned by political intriguers, and hence, the people died. What gross ignorance for 1832! Mark the consequences. The mob rose in numerous assemblies. "Never," says M. Grisquet, then Prefect of Police, "was there seen in Paris so frightful and numerous a mob, maddened by the dread of poison, and rushing in search of the authors of these imaginary crimes." What a fearful picture of human ignorance! "Every person," continues M. Grisquet, "seen with bottles, vials, or small packets, became an object of insane suspicion. For a moment I trembled for the city; for the lives and property of its respectable citizens. But the popular fury vented itself in acts of individual atrocity. Three or four victims torn in pieces by the infuriated mob sufficed, and in the end they

dispersed; satisfied with seeing one whom they were about to murder, eat with impunity the suspected object which he held in his hand." After such a scene further examples need not be given.

Now to contrast the bliss of knowledge. Peril of suffering is not the stimulus which actuates the great and good to acquire, but rather capacity to enjoy. We know not the real value of life; we are insensible of the great blessings we daily receive, whilst we remain in ignorance. The assertion made by one of our poets, that ignorance is, or ever can be bliss, is false. Ignorance is a state of death-like stupor compared with knowledge. As well say death is bliss, as ignorance. There may be certain cases wherein it prevents suffering by its death-like action, like powerful narcotics, or death itself; but bliss is a widely different state to insensibility. Whilst in ignorance, so apathetic are we, that we regard existence without affection, we look upon it with little or no delight. But in the light of knowledge, not even a blade of grass escapes the eye without calling up its emotion of pleasure. Who then shall measure the amount of feeling produced, when man comprehends his wondrous frame, standing in all its complex relations both to earth and heaven? When from an eye beaming with light, he looks out upon the glowing sky, refulgent from its radiant sun, or contemplates the scenery of earth, and all the various relations in which he stands connected with it? Let each gain this position; each realize this state; for then, and then only can be known, the inexpressible bliss of knowledge!

Thus much in justification!—or rather an attack on one of the strongholds of falsehood—prejudice. And now to our subject—physiological truth. The path is surely open now; and the mind unencumbered with this draw-back of ignorance, impetuously darts forward to seize on its object. Stay! Its object is but an appearance. Its hasty grasp but a first impression. Man must be wary, or the child may prove his master. Thus the matured intellect of the past, falls before the young mind of the rising generation. To profit by the study of physiology, each needs to undergo a previous education. Fact and theory, principle and appearance, terms and things, past and present acquirements, must

each and all be comprehended, and their relative values ascertained, or physiology will be but a comparative blank after all our labour; may be a positive evil, a stumbling-block of sensuality to prostrate a nobler nature in the dust. To gaze on the heart as an hydraulic machine, and the spleen as package, are specimens among the early results of such rash proceeding; and its crown, a belief that a Frankeinstein can organize a structure, from which life will spontaneously arise. A monstrous fiction with a monster for its issue!

What is a physiological fact, what its theory, and what their value? What are the principles which should assist in judging of physiological appearances? The relative bearing between the scientific name, and the thing it represents? The worth of past opinion, and the amount of present knowledge? These are all questions the philosopher must settle with reference to every point he would decide upon in this study, or he will risk his conclusions to be at the best, but superficial, hasty, short-sighted views. The philosopher, unmindful of these things, and the ignorant, nervous and fearful, are both equally blind; though one pretends to lead the other. The philosopher thus rash, by reason of conceit, like the undevout astronomer of Dr. Young, is little less than mad. The physiologist must have a method in his ways, and *we* must look to this subject, before we understand the sequel.

The management of mind in all intellectual pursuits, manifestly proclaims itself of paramount importance. Attention or carelessness to it makes all the difference between the wise and foolish. The same matter of fact, the same nature, lies spread like an open book for all to read. The variety in the reading is solely owing to mind. And thus it is, that some condemn others for being too theoretical, nay are averse to theory in toto. And some are found to place no value on any but modern opinions, pointing to the past, as an era all barbarous and rude, just emerging from a mere animal condition; hence, value not in setting forth new notions, any principle or name however dear in days gone by which clash with the modern view. Whilst, on the other hand, we have seen obstinate repugnance to advance, joined with timid doubt; we have seen the theorist shutting his

eyes and trembling, for fear an object should appear ready to condemn his idol, or his explanation should only meet with scorn from the stern scepticism of his opponent.

These wars of extremes are the common consequences of a too general inattention to mental economy. Let us learn to avoid them, and be warned by their example. So shall we gain the happy medium—enter into the state of meditation —receive wisdom—and returning with it to the world, bid it "God speed" to catch and conquer men.

In studying physiology, and indeed every other branch of natural philosophy, all first impressions are to be doubtingly viewed, and no settled opinion should be directly formed on them. This must be evident to all who have thought upon the matter. How do we obtain knowledge? It is thus. An appearance is presented to us, that is an object appears. But this is not knowledge. It is simply a relation formed between the object and the mind. The mind must comprehend the object. The comprehension of the object is knowledge. And as far as mind comprehends aright it possesses knowledge. None however can comprehend aright, but the experienced and well informed. This is evident, for the experienced and inexperienced, the foolish and the wise, each sees the same appearance, but the comprehension of the one is wise, and the other foolish. Hence it may be seen, how the first impression formed by the appearance, may be, and often is deceptive. To the foolish it is always deceptive, but with the wise, always comprehended aright. If mankind had but generally considered thus, the history of human discovery, would not shew those numerous instances of truth in its single hand struggle with the mass, which now disgrace its pages.

From appearances, we next arrive at facts and things on the one hand, and theories, principles and terms, on the other, as they occupy the individual or universal mind from its commencement to the present. We call the appearance a fact or thing when satisfied of its existence, but with caution; false facts, and false things, are very common in the history of the past. We call the intellectual view, a theory; not oftener false than what we call a fact; perhaps not so often, for the intellectual eye of man is a superior vision to his corresponding bodily organ. And these two, fact and theory,

external impression and mental comprehension, make up the sum and substance of our inquiry whatever it may be. And now comes the question—hitherto we have only stated the position—the question how to tell what is true or false in fact, true or false in theory. This brings the mind to draw on previous knowledge, and its terms of speech, stored up in memory—the principles it acknowledges, and their expression. These, the reflecting man weighs with the appearance in consideration; the hasty, disregarding; the prejudiced, bigotedly adhering. The reflecting man, I say, weighs the matter with all his previous knowledge, especially his principles of knowledge, before he forms his judgment. In this wise let us imitate. Physiology has not yet had justice done her in this manner. We know not what plenty she has in her rich and ample lap, to bless those who seek her in this spirit. To express my own conviction and belief, healing for all, and value in addition, scarcely imagined, almost inexpressible!

Shall I be called an enthusiast for making this statement? An enthusiast, with a science before me like physiology! A midway station between earth and heaven! A point of union where life and beauty meet! Life, from within, o'erflowing. Beauty, from without, commingling Let the great German poet speak. I can no more.

"See all things with each other blending—
Each to all its being lending—
All on each in turn depending;
Heavenly ministers descending,
And again to heaven uptending,
* * * * * *
Breathing blessings, see them blending,
Balanced worlds from change defending,
While everywhere diffused is harmony unending!"*

I fear lest my introduction should be thought long. But permit me to recapitulate what I have done in that introduction. I have set forth the subject, contrasted it against prejudice, and shewn how it is to be followed up with profit to the student. And I conscientiously think these things worthy the time they have cost us, whatever their treatment at my hands may deserve.

* Goethe—translated by Dr. Auster.

In searching for the leading features of human physiology, we discover we are actually engaged in making a grand analysis of the universe. Matter and spirit, external developement and internal agent, are both included on the grandest scale. Animation, vegetation, and fixation, in all their degrees and most varied phenomena, are combined to form the human being: wonderfully and fearfully made! The vortex of perfection centres *here*. Here, every bound and limit seems chased away, and man receives from all, and gives to all, as lord and master of the finite world.

Let the mind look from the eye of sense but superficially around. Innumerable are the organic forms in which it dwells, of every imaginable shape and use. Distant some—how distant! Proximate others—so near that they seem one with the thought which views them. Yet each and all in their respective places. Each to perform its destined purpose. Drink deeper next. Look now beyond the surface. A sphere of active agents are discerned—above, beneath, in all. Powers of affinity of every degree of intensity and force, fix solids, fluids, gases—pile Ossa on Pelion, and establish the enduring globe. Thus Life begins. Order established and preserved, demonstrates life. The germ bursts, it spreads, it grows. Developed in a form most chaste, and exquisitely beautiful, the vegetable rears its head, filled with fragrant odour, and covered with the richest dyes. Life of a higher order stands confessed, superior in its kind and less tenacious of its dwelling; more concentrated, its empire less extended, less enduring; its summer passes and its reign is gone. We journey by plant and mineral, travelling from circumference to centre, not yet arrived at home. The animal kingdom, wherein flesh and blood become the feeling subjects, and instinct works with curious labour, supervenes. Here the phase of life fills fast, perfecting its fulness. Nearer and nearer approach is made in the completion of each class and order, family and kind, till in the end, MAN, the great type of all, the soul and centre, keystone of the whole, perceives in outward nature a finished work, answering to his every thought and feeling stored within.

We have made our survey. We have seen a world of sensuous images replete with life. We have seen the human thought centered in this world, springing forth to

witness and respond with conscious feeling. And we ask—Whence and what is it? The fairy scene, the busy world, the bliss, the woe, the pleasure and the pain. We form opinions at length by our rules of judging, various with various minds; some degrading, some exalting to man, at once their originator and their subject. I stay not here to answer these questions. We have not yet looked far enough to do so. To generalize, and so grasp our survey in a closer fold, and to proceed. Universal nature has displayed a three-fold order of power, in a three-fold order of form, as we have seen, and the mind has been enabled to perceive this by dwelling within these powers and forms. In man's physical frame all is comprehended. Animalized, animals are associated with it; growing, the animal displays the vegetative power; and subsisting, its fixed points are shewn. In the physical frame the mind perceives all nature. The object distant a myriad miles, lies impressed on the retina in rays of light. The pealing thunder vibrates in the ear. All is perceived by means of sensation residing in the body.

After this brief survey of the constitution of man in his adaptation to an external world, my design is next to call your attention to the connection which exists between the organic structure and the hidden world connected with it, and covered by it, as it were with a garment. From these two views, one directed *without*, and the other *interiorly*, we gain a perfect knowledge of our physiological situation.

And now we ask WHAT IS LIFE? The child and the man, the ignorant and the philosophic, the sceptic and the believer, all have, times and often, wondered and considered, and the general result of their inquiries has been that it transcends their idea. . Yet as the cause which animates, develops, and sustains all things, in the supremest harmony and delight, we most of us recognize it. To answer this question, the materialist has sought for it in the dissecting room, and in the tomb; and the spiritualist, assured he is not to seek the living among the dead, much less life itself, finds it in God. Each, however, feels it as his own, searching to find its origin. Each is intent upon his labour; but with what difference of feeling. The one, to level his condition to that of the beast, whom he believes to perish. The other, to enjoy the dearest wishes of the human heart, after all his

cares, and toils, and troubles, working for good. Let us turn to this question. Life constitutes the world within. What are its leading features? Whom do they most favour? He who considers it merely as the offspring of material function, or the philosopher who contends it is the spring and source, not only of all function, but of the material itself?

The various periods of human existence first present themselves to our notice, as bearing on this question. When we contemplate the process of formation and birth, first beholding the body growing from origins too minute for observation, wonderfully combined and adapted to subsequent use, we pause to inquire—What can make this growth, so admirably designed and beautiful? We find its cause rests with the parent, and cannot spring from the newly-organized being; for separated, the delightful process ceases, resolving itself into a little volatilized dust. Perfected at birth however, all seems sustained within the little creature, and the series of animations are next developed, for which each previously formed organ now shews itself adapted. Like a leaf or a flower in its bud, genial circumstances unfold the infant mind, and we are satisfied, from the thousand little acts we witness, a life similar to the parents' lies concealed and only requires time and place to bring it forth; and we are right. In time, the grown man, with a capacity to comprehend, and heart to love, arrives at the meridian of his power; unconscious of his own strength and greatness till called forth; immense, incalculable powers lying latent in every soul. Now the sources of mind seem infinite, and to imagine that they spring from a frame, which but a few short years ago did not exist, appears too much for any one to credit. Approaching the grave, men say their knowing faculties grow dull—duller the worse they have been used; the feelings formerly cherished cold—the more worthless, coldest; their perceptions less acute—from physical rigidity, induced by years of worldly contact. No wonder. They are tired! Like sleep, death steals upon them. Night has arrived. Shall they never awake again? Imagine the man who first watched sleep. Was he sceptical? If so, he was deceived.

The peculiarities of the human race, and the lives and instincts of animals, form another series of objects, affording most interesting particulars in reference to our subject. The theory that mind is merely the result of sensuous impressions, themselves solely the effect of material arrangement, is wholly at variance with these peculiarities. For instance, Shakspeare and Byron, Newton and Davy, were remarkable men, units amongst millions. Yet what so remarkable in their external education, or physical impressions? Certainly nothing to warrant the idea, that a difference here effected the difference which existed between their minds and those of their fellows. Again, some men are cold and callous, naturally so we style it. Try and impress them, and you will find all your efforts cannot bring forth warmth of feeling. But use the same means on a warm and generous spirit, and you will presently be overwhelmed with an effusion of love and sympathy. Again, with some, if every possible pains were taken to instruct them, it is but labour thrown away; whilst with others, every circumstance, however trifling, is made of value and turned to account. All these cases bespeak a difference in the state of life, and refuse explanation from the material theory. Also, if we look to the instincts of animals, we ask, is it credible that any external necessity could have taught the various acts which they perform? The ant or bee, to govern their hills and hives of busy communities? The birds, to build their nests, to procure their proper food, avoiding poisons so plentiful in the vegetable world, to migrate to suitable climates, or as the carrier pigeon, to cross seas and countries to return to the home from whence he had been carried? The fierce, treacherous, and blood-thirsty tiger, the lamb with a gentleness, docility, and a kind of domestic affection, the elegant camel-leopard, and the disgusting boar, these also are varieties that no habit or circumstance could have originated. Yet they are but a repetition of what we find in man, in whom, every variety of animal instinct is comprehended.

Extraordinary occurrences, which would require the most absurd and infatuated incredulity to deny, are constantly presenting us with information relative to our inquiry—the origin of life. Such, for the most part, entirely refuse any

explanation from material hypothesis. From the earliest records of miracles, down to animal magnetism in the present day, life has displayed wonders, referring it to a spiritual source, and showing it dependent on organic structure for nothing but an earthly habitation. So also, various of the common events of every day, which none will attempt to deny, if examined, can only be accounted for upon the supposition that life is independent of organization as a cause. Continual mental suffering, we have seen to kill the body, whilst an increase of happiness prolongs its existence, and of this we have ample statistical accounts of the most general application. The passions, each have their effect in increasing or retarding the functions of every organ. Intense grief has so altered the human countenance that its likeness has been lost in a day. A spare and lean habit is quickly produced by thought, and fat accumulated with the easy temperament. In the constantly occurring scenes of mortal frailty, in instances of self-possession, and in states of abstraction, in cases of love, who has not witnessed the independent operations of the soul? For instance, one word in a man's ear may drive him mad, cause a swoon, call forth violent rage. How absurd in such a case, to attribute all this solely to the agitation of nervous fibres in the brain or elsewhere occasioned by this one word! Abstracted men have lost their limbs and not known it at the time. Self-possession has carried us all through scenes, which would have been destructive without it, showing the independent position the mind is capable of assuming with respect to its corporeal tenement. And shall we be told that that tenement creates it? We all know the power of sympathy—to love and to hate. Who can think of accounting for these states by organic solution? Lastly let us witness sleep—the total oblivion of life. What organic cause can account for sleep? Like Lethe, banished by sweet memory, sleep passes, and we live again! The delicious repose of the soul, which not a few great men have fancied to be heaven—Socrates questioning if death be sleep—stealing over us at its stated period, shews no adequate cause in the corporeal frame, which in such cases simply obeys its sleeping spirit.

Judging from these, and like considerations, *the source of life* seems far otherwise than the surface. Like the chrysalis,

wrought by a worm, and burst at length by a flying gem, so human existence seems prepared by inferior, to yield eventually to superior being. Animal, vegetable, and chemical powers, (all of which may properly be called life,) jointly combined, appear to have formed the vast material fabric, both us and all around. Animalizing, developing, and fixing. The last, (acting in time, the first,) also producing. This done, superior yet the stores of life unfold. Within the form we have seen the powers of growth and feeling, now thought and soul are manifest: a searching faculty to ascend from sense to judgment—from sensual gratification to purer and more exalted joys; longing for good, thirsting for truth, appreciating beauty. This is the being which is above the worm, and may at length burst forth a glorious gem!

First impressions, it is true, raise a number of objections against these views, persuading us, that it is the brain which thinks, the eye which sees, the ear which hears; and common phraseology of speech, formed in every instance accordiug to the appearance, favours the delusion. But how much more correct to say, it is I—me—myself, who think, see and hear, and not my or mine. My eye is only the optical instrument, I use for seeing. My ear, the acoustic instrument I use for hearing. My brain, the nervous instrument which finally receives all impressions, and presents them to me—myself—its spirit—its master and its lord.

> "This frame, compacted with transcendent skill
> Of moving joints, obedient to my will:
> Nurs'd from the fruitful glebe, like yonder tree,
> Waxes and wastes—I call it MINE not *me*."
> *Arbuthnot*

Yet we have a string of questions put forth by the advocate of the supremacy of dust and ashes. From his barren ground he questions pertly enough, and sneers at theory. Vain imaginings! Matter of fact, alone will suit at his opponents' hands. Holds he no other weapons in his own? In his grand question, "Does not injury done to the brain destroy life?" he assumes function and life to be one and the same. A bare assumption. They appear one as cause and effect seem one, and hence his assertion. Appearances in this, as in all his other questions, are his only defence and guide.

To pass on to structure. In structure the human body seems mainly subservient to two great ends, namely, the formation of the organs of sense and motion, and these evidently for the purposes of mental improvement and education; for which end alone, the spring of life issues from the heart, the organs of assimilation supply the vital current, and various modes adapted for its purification are kept at work. The centre of the organs of sense is the brain, whose function is to receive and concentrate all sensuous impressions, and make them apparent to the life. The organs of motion have also the same centre, with which they are connected by nerves. And as the brain receives all impressions from the senses, so it causes all motion to be communicated to the extremes. It is thus, physical existence is wholly subservient to the one great purpose—*spiritual education.* All is one continual progression and retrogression, flux and reflux, action and re-action, from the brain itself to the extremities not only of the body but of the universal solar system; for this end—the education of conscious being—of a world of mind. Deeply ought we to feel this our position. All things created for us. Looking at our bodies, we have been called worms; at our souls, gods, and with the greater truth. Our bodies are concentrations of the vast external whole, built up around the spirit, to present it with every surrounding influence.

This noble nature, with which we are endowed, is indeed a privilege few can adequately esteem; its use, an occupation none can sufficiently rejoice in; its abuse, a misfortune; how great! the sufferer in mercy knows not. In matters of sense, (the subject now before us,) use and abuse make all the difference between the stoic and the voluptuary—the man who is truly the greatest of conquerors and heroes, or the prostrate slave of vice. Let none then slur their lesson. The consequence of abuse, is to destroy this noble fabric, to induce and propagate disease. The early christians, living on bread and water, often passed their hundredth year in all the vigour of manhood.* St. Antony, James the hermit, Arsenius, St. Epiphanius, Simeon Rombold, and others, holy, temperate, strong, and cheerful to the last. And we, have

* These examples are taken from Donovan's Domestic Economy. Lardner's Cyclopedia.

had a Parr, who, living mostly on bread and milk, reached his 153rd year. What a contrast the epicurean presents. Never satisfied, yet ever suffering. With unwieldy body, purple face, suffused eyes; disqualified from all exertion, disrelishing every other enjoyment but his gormandizing propensities, now his master; urged to every act of cruelty and depravity, as the slow lingering death of the calf, boiling lobsters alive, flaying seriggling eels, stuffing fowls, with other like unmerciful proceedings testify, even now, a tolerated disgrace amongst us. And all this misery comes of a man's not understanding the physical and moral order of his creation—to advance from matter to mind—to seek for happiness in permanent and not in temporary possession. To use his corporeal existence for any other purpose is to abuse. It is the same with the pleasures of sight as with the palate. Man may easily become giddy with sight seeing. The propensity may increase till the world holds not sufficient variety in its healthful scenes of beauty to gratify him. Hence he arranges artificial scenes of disgrace, and stops not, till he sees a burning Rome with Nero, or shouts in the gladiatorial circus—the papal court of an Alexander, or some of the modern scenes which disgrace our European stage! These two instances of sensual abuse may serve for others. They are not extremes either of them. Delicacy compels me to avoid extremes, to all of us, doubtless, subjects of disgust.

Health and disease thus brought before us, remind me to speak of remedies. And these are of two kinds, like all other influences which act upon our bodies; internal and external, neither to be lost sight of by the physician without danger of empiricism. To cure indigestion, with all the gormand's propensities at work, alone by physic, or such morbid state of the digestive organs as gluttony induces, alone with repentance, and careful dieting in future, is not possible. So also with every other malady. Each is induced by a want of harmony between life and its subject; and in all, harmony must be restored, or health can never be regained. So he, who knows the greatest number of particulars concerning this disorder, and methods for its removal, is the best practitioner. In hereditary diseases, such as scrofula and consumption, how marked is the state of mind—precocious—

ritable. Half the treatment of these cases must be mental. Tonics, to strengthen the debilitated frame, is only half the remedy. In fever and inflammation, all know the patient's sanguine temperament must be kept quiet, or the bleeding and antiphlogistic medicine will be of no avail. Plagues, when they sweep over a nation, follow the same law in striking down their victims. Similarity of habits, shewing similarity of minds, usually characterizes those who fall. And hence we see the malignant pest often powerless to harm the medical attendant or the priest, who lingers with the dying and the dead.

To observe the series of minor uses by which the above mentioned great uses of the body are accomplished, we must look into the mechanism comprising the body, as we would open a watch to see what causes the hands to move—the great use performed by the watch; always remembering that the mainspring of the body is life, subordinate in its action to mind, like every thing else in creation. And in this investigation, one of the first remarks we make, if we study comparative anatomy, is, that the higher animals are all endowed with the same organs as ourselves, with trifling varieties; and that all animal organs more or less partake of our own construction down to the medusa and the polype, with a single sac for a stomach. A fact which alone ought to convince, that the soul is no offspring of corporeal arrangements; for, even admitting animal instinct to be from thence, what animal is capable of appreciating any state of being? still they have all our natural propensities and instincts, for those development they live—everlasting monuments to teach the proper value of such faculties, and that they cannot constitute the nobility of man, but are intended solely to administer to his wants. In the lower forms of animal life, we have first merely a circulation from centre to circumference, constituting the radiata of zoologists. Here, from the absence of all locomotive powers, and the scarcely perceptible degree of sensation which is manifested, we are puzzled to tell where animal life may truly be said to be or not. Ascending through mollusca, insecta, and reptilia, the organs gradually assume more the cast of those we carry; and in vertebrata, we find our own accurately pourtrayed—so accurately, that in the ape, even the erect posture is

maintained—the peculiar attribute of man, as the latin poet proudly says

"———— cœlum que tuerri
Jussit, et erectos ad sidera tollere vultus."

In order to explore the organic frame with profit—to ascertain its functions, our duties with respect to it, and its value to us—the most careful study and patient investigation are required, together with the diligent application of knowledge from every other possible source to assist in our conclusions. Little can be done in a single lecture in illustrating such a field of inquiry and scientific research further than giving the few hints which I have already done, and offering to the student a general view of the subject in its vast and sublime connections, that he may not set down to it in a narrow-minded or restricted spirit. This also I have attempted; and in the following slight demonstration of the organic frame, will endeavour, with your permission, to carry out yet more into particulars.

We shall do well in this work to take up the subjects successively as Nature offers them in her ascending scale, and firstly, the digestive and assimilating apparatus, by which matter, external to the organs is associated with them, and becomes a constituent part. This process of associating fresh material with the old is constantly necessary, for the whole living body is a perfect vortex of motion. It perpetually exhales a sphere of vapourized matter called perspiration from every point of its surface. Lavoisier says as much as would weigh 24 ounces from every man in the day, at the lowest average. Assimilation of foreign substances is a universal requisite where growth and change are required, and hence is also performed by vegetables as well as animals. Plants are nourished from the roots. The lower order of animals imbibe food from pores extended over their surface, or by means of an open sac, which affords the first instance of an alimentary canal, to which as we rise in the scale of existence, mouth, teeth, and lastly a continuous aperture, are added. We derive support by means of such an apparatus. Plentifully supplied by the bountiful hand of Providence with food, our terrestrial paradise is filled to overflowing.

ne condition alone necessary to live—to eat. Gratification, ithout alloy or danger, following the purely useful act.

Falling into the stomach the aliment is digested, that is, is nverted into an homogenous substance by a process similar fermentation. Here an interchange of its constituent ements seems to take place by the addition of the juices of e stomach, and however various the food we may have ten, all now appears reduced to one substance; unnecessary uids or gases most likely being removed by the absorbents the stomach. The digested food of a semi-fluid consistuce next passes into the intestines, where it separates into o portions; part, nutrient, pure, and white like milk, cending through numerous channels into the blood; part, crementitious. This separation seems also to have manded the presence of new agents. The seeretions of e liver and pancreas each mixes with the digested food effect it.

Here—in the process of replenishing the blood, and hence e system generally, and thus enabling the constant change go on which life requires—we learn a most valuable lesson. fe cannot exist without activity, constantly diffusing ound its influences; hence cannot exist without a liberal pply of fresh material, which is most bountifully given and sily assimilated. This is the arrangement; but a comratively soul-less one if man can see no further. This aterial ordinance is evidently in accordance to the universal d—*immortal use*. Life, which will give and must receive, mands our best attention. We are called upon to feed it. ne idle and the wasteful, the sensual and the profligate, us meet with their desert; the frugal and the industrious, eir reward. Here, the education of mind is evidently the sign; not perhaps immediately apparent to the intellect, t always in our praetice and its operation.

The next series of organs presented to us by nature, after e digestive, are vessels for circulating through the body the urishment in a fluid state afforded by digestion. This is ected in man and the higher classes of animals by a heart d blood vessels, and in the lower, simply by vessels. The urishing fluid is called blood, and is diffused in rapid and ntinued motion over the whole body. No point, the most nute, is without its blood. The centre of this perpetual

movement is the heart, which, night and day, so long as life remains, is continually in action, pouring around in one continuous fountain of innumerable jets, and in every direction, its crimson streams. The golden shower of Danae, in fiction, fails to equal this beautiful reality—our portion every instant! The heart—magnificent palace of love—thus cherishes, supplies, sustains, creates the whole! All is blood, bounded and brought into organic form by the plastic powers of life. Well may the blood be styled the life; for blood is its animalized organic form. In the blood globule the life resides. From bone to nerve, that is from least to greatest in the order of vitality, all is a part of this living vortex.

Blood, however, is not simply the chyle of digested food—the nourishment derived by means of the stomach. From vegetable and animalcule upwards, the nutrient juices are partly composed of digested air, as well as digested solids and liquids. Air enters the leaves of plants to mix with the circulation ascending from the roots; penetrates the surfaces of the lower forms of animal life; breathes through the butterfly's wing; and in the sea also finds its way to the gills of fishes. Infinitely diversified are the various ways in which the balmy influences of heaven enter the body to become a part of the rich dancing stream of life, the lungs in man being the type. The gases of the air enter the lungs by means of the mouth and nostrils, and through passages called the bronchial vessels. The chest is enlarged by respiration to receive the air every instant, remitting back a portion after each breath. As with food received by the stomach, so with this aerial nourishment, a separation takes place when it is introduced into the system; and part only is received; the remainder being expired, together with a great quantity of another gas called carbonic acid, which is evolved from the blood at the same time.

The moral uses of respiration are not less important than those of the stomach already noticed. Considering the functions of the lungs, we further learn the true relations which one portion of creation bears to another; enjoy, if we obey; suffer, if refractory. Man, we thus discover, is intended to live in the open country, and to study his lessons from the objects of nature. Artificial society, crowded in

moky cities, and confining its members pent up in ill entilated houses, wastes man's strength and shortens his ays. The continual, care-consuming drudgery, our nultitudes daily undergo, is alike forbidden by nature as by onscience. God's works are all harmonious. The function f respiration has ever taught man thus, and now he begins o believe that it teaches truly. He enlarges his streets, entilates his apartments, gives up some of his time from the ear-earned penny—would to God, the poor mechanic could o the same!

The secreting and absorbing systems, as they are called, next present themselves to our notice. Constant activity eing the necessary condition of life whether mentally r physically operating, stagnation—torpor—death—being ynonymous, the blood ever renewed *from* without, must ver circulate *to* without. Nothing can be isolated, nothing nactive, though the degrees of active reciprocalness may be ndless in variety, from the hybernating dormouse to the agle in his flight. Hence the body contains in every part rgans for the purpose of change as well as for the purpose f assimilating. These organs are of a peculiar structure alled glandular. A kind of porous substance, sucking up nd squeezing out, familiarly to express their uses. They re situated in every portion of the body, and connected ogether by a system of vessels carrying the result of their perations, which from its limpid watery appearance is alled lymph. They vary in every possible degree of size, rom the minutest speck to our largest organs. Their ommon outlets are from every part of the surface—the skiu, he lungs, the kidneys, and the bowels; hence deficient action n any of these, in their excreting processes, are sure to cause tagnation and give rise to disease. The various maladies alled colds are consequences of checking the action of the kin, and bilious fevers, &c. follow constipation. The liver, idneys and pancreas are all organs of this kind. The soul-nstructing economy of this system lies in its demand for ctivity. It will not work if man is inactive. Not that it equires him to be all day in exercise, such would injure and in ime destroy; but it absolutely demands that a part of his time hould be given up to the pursuits of manual labour. Well vould it be for all, if each heeded the lesson taught by the

workings of the absorbent system. The fat justice and the half-emaciated artizan would then each gain their fair proportions. The useless maiden of sighs and hysterics would delight in her household occupation, and the victim of study—a Kirke White, or a Davy, would be spared yet longer to be their nation's pride.

Concerning the brain and nervous system I have already spoken. The function of the brain is to receive all sensuous impressions from without, and transmit all mental emotions from within. Also, concerning the use and abuse of sense, I have treated as fully as time and occasion will permit. Here, therefore, I need only remark that the nervous system is the centre of the body, the prime effect of all we have been speaking of, for whose formation and preservation the blood flows and is constantly refreshed anew; so that the slightest stoppage of the circulation is followed by fainting; more serious hinderance, by apoplexy and death. This system more or less developed, is discernible wherever sensation or animal movement is to be perceived.

The external frame of bone and muscle, with its covering integuments, complete our subject. Nerve within; bone and muscle without; both the work of the heart's best blood with all its auxiliary attendants, are the two great ends of human structure. And, as without the nerve the heart would beat in vain, so without the muscle and bone, the nerve would vibrate to no purpose. Brain and nerve, nerve and muscle, muscle and bone, play with each other in succession; and the blood bounds through the whole like an electric chain. The muscles are bands of flesh fastening from bone to bone, each band consisting of numerous fibres, each fibre receiving a nerve. The nerve, at the bidding of the *will*, vibrates—the muscle obedient, contracts—the skelcton of articulated bones, moves! The skin throws a veil over all. We have dared to withdraw its covering. I trust with profit. Gently and piously it becomes the student to enter upon this holy ground, the veil being withdrawn, to contemplate the noblest work of God.

LECTURE II.

ON UNIVERSAL ARRANGEMENT.

PART 1. FURTHER EXPLORATION OF THE VAST PROPOSED—WHY EXISTENCE IS AS IT IS—EXTRACTS FROM MISS MARTINEAU AND EMERSON—TRUE DISCOVERY—SCIENCE AND REVELATION—NATURE NOT INFINITE—HOPES IN THE MIND YET TO COMPASS HER—THE PERFECTION OF THE ANCIENT TRINE EXAMINED—APPLICATION OF THE TRINE TO NATURAL ARRANGEMENT—SUBTRINES—AFFINITY AND ANALOGY.

PART 2. MAN THE SOLE TYPE OF THE NATURAL WORLD—THREE-FOLD ORDER OF HIS EXTERNAL FORM—THREE DISTINCT SPECIES OF THE HUMAN RACE—HUMAN SUBTRINE—THE GRAND TRINE OF NATURE—THE ANIMAL, VEGETABLE AND MINERAL KINGDOMS—THEIR SUBTRINES—ANALOGIES AND AFFINITIES.

PART 3. MAN ANATOMICALLY AND PHYSIOLOGICALLY THE TYPE OF ALL—THE ORGANIC TRINE AND ITS SUBTRINES STATED—THE ORGANS OF SENSATION AND MOTION DESCRIBED FROM MAN DOWNWARDS TO THE ZOOPHYTE—THE BRAIN—THE SPINAL CORD—THE SYMPATHETIC NERVES—THE EAR—THE EYE—THE SENSES OF SMELL, TASTE, AND TOUCH—THE SKELETON—THE BONES ARRANGED IN THREE-FOLD ORDER—THE ANALOGIES OF THE HAND—THE MUSCLES—THE SKIN—WHY MAN IS NAKED—THE HARMONIES OF ALL THE ABOVE—THE ORGANS OF GROWTH, PRODUCTION AND WASTE DESCRIBED FROM MAN DOWNWARDS—THE ORGANS OF REPRODUCTION ALLUDED TO AS A TRINE—THEORY OF ORGANIZATION—BLOOD VESSELS AND STRUCTURE—THE SPLEEN, AN ABDOMINAL HEART—ALIMENTARY CANAL, MESENTERY, AND THORACIC DUCT—THE FOOD OF ANIMALS—RESPIRATORY ORGANS—DIGESTION OF FLUIDS—ORGANS OF WASTE—THE ABSORBENTS AND SECRETING SYSTEM—CORRESPONDENCES BETWEEN THE LIVER AND THE LUNGS—THE EXCRETING SYSTEM—CONCLUSION—ONENESS OF CREATION AND ONE CREATOR.

Before we commence a second lecture* permit me to call your attention to our last meeting, to remind those whom I then had the pleasure to address, and to inform those whom I may now see for the first time, of the position in which both lecturer and lecture were on that occasion presented to you. As regards myself, it was my introduction, and as far as I then knew the expected ending also of our present

* This and the two following Lectures were written in intervals of a fortnight each, to meet the demands of the Mechanics' Institution.

acquaintance. Hence I chose to treat my subject in very general terms, offering rather a sketch than a picture of my physiological labours. I now stand before you called upon to fill up that sketch. An unexpected honour. Unavoidably hasty are my preparations. Unlimited therefore I crave your indulgence. Unbounded therefore is the confidence I need in my own internal resources. Much I feel I require to bring me here once a fortnight, in justice to my subject, to you, and to myself. Much I feel I shall receive at your liberal hands, and from that support which is ever given to him who works with pure intentions—to discover the well being of man, and the glory of God.

The subject I last brought before you was Animal Physiology in its vast and sublime relations. Vast, by reason of connexion with an external world filled with infinite imitations; sublime, by virtue of a hidden world of agency and power residing within its organic forms. And the end for which I then strove, was to shew how all was ordered to serve the great use of mental education. This I recall, not so much now because we would try a second time the eagle's wing, as to fix it upon your mind that thither our subject ever tends. Ere we attempt again the lofty flight, we need strength, and food, and respite, which the rich and luxurious garden, it is our privilege to tread, will amply satisfy and yield. It is from the vast, spread like an ocean or a field of light around our garden, it is from each object growing in its beds, from universal science and particularly physiology as a branch, we must first gather our detail. As I stated when treating of study, we must first look for the fact or thing as it appears in nature, examine and compare. Would we judge of electricity, we must observe the bodies on which the power so called is operating; so also of heat and light, gravitation and affinity, animal and vegetable life. Of these, and of all else, we can only learn by observing the phenomena which they externally present. Hence corporeal sense is given, first to present us with corporeal things, judgment is added that afterwards we may discern their meaning.

A popular writer in the people's edition of a very popular book,* propounding all the subjects of human inquiry

* "The Constitution of Man," by Geo. Combe. Vide Chap. 1st.

says, "the first is, what exists?" and this truly is the first enquiry. But why existence is ordered as it is, he gives us to understand is in all probability beyond our faculties; still that there really is *a why*, none but an atheist ever doubts; and what this *why* is, we all know from experience man is continually yearning to learn. Is the question a forbidden fruit, or, as the fable says, only sour grapes our author has himself failed to reach? Let us examine. Conducting our scientific research as we purpose doing, to true ascertaining of a meaning, the question is of paramount importance. Not one however to be settled in an evening or perhaps in a dozen with the sceptic. To convince any in favour of man's rational powers on this subject by an a priori argument is not my aim. I would simply place before your notice the acknowledged legality of the ground I wish to carry you over, and leave each at his leisure afterwards to judge from the whole collected evidences of my discourse.

The best and wisest of men have generally formed conclusions to what end they live, and why nature teaches. The hesitating party whom we quote is small both in worth and number, and in this instance avowedly ignorant at their own shewing. In all ages and in every nation, men when raised above a mere sensual condition, say it is *to live for ever* they were born, and nature is as *a school mistress* to their souls. This is the universal testimony of our race, and must be weighed accordingly. And after looking separately at the arguments such men have used to give a reason for their hopes, few entertain a doubt but that man does know *the why*, and can appreciate *the wherefore* of existence.

The immortal desire as it burns in the noble breast is as splendidly pictured by Miss Martineau in her lately published scene between Toussaint L'Ouverture and the banish Priest.

"Priest—So here ends your career!

"Touissant—From no one so often as you father have heard that man's career never ends.

"The Priest made no reply.

"How lately was it, pursued Toussaint, that you encouraged my children, when they, who fear neither the bull

nor the tornado, looked somewhat fearfully up to the eclipsed moon! who was it then but you that told them that though that blessed light seemed blotted out from the sky it was not so; but that behind the black shadow, God's hand was still leading her through the heavens, still pouring radiance into her lamp, not the less bright because hidden from man? A dark shadow is about to pass upon my name; but is it not possible, father, that God may still be feeding my soul with light—still guiding me towards himself? will you not once more tell me that man's career never ends?"

The teachings of nature are thus beautifully drawn by the American Emerson.

"The moral influences of nature upon every individual is that amount of truth which is illustrated to him. Who can estimate this? Who can guess how much firmness the sea-beaten rock has taught the fisherman? How much tranquillity has been reflected to man from the azure sky over whose unspotted deeps the wind for ever more drives flocks of stormy clouds and leaves no wrinkle or stain? How much industry and providence and affection we have caught from the pantomine of brutes? What a searching preacher of self command is the varying phenomenon of health!"

Thus supported I shall proceed at once to fill up the outline I lately presented to you of *the constitution of man in relation to an external world physiologically considered.* So shall we gain material, and on some subsequent occasion be enabled I trust to enter more fully than we have yet done into the vitally important question—what is life?

Launched in a vessel of discovery, the broad waters of science tossing around in waves or sweeping by in currents, look we to our helm and compass, charts and soundings! No navigator puts to sea without so doing. Let us attend to the allegory. It instructs us not to forget to take our principles, and previous knowledge with us, not to despise the teachings of our fathers, however we may find it necessary to correct errors as we proceed. Would we discover truth, like the sailor watching the motions of the heavenly bodies, we must have some glimpse of that which is beyond the bare earthly object, even though it looks to the infinite

and eternal. And why should it not be thus since it is granted to man to discover—since man is made capable of revelation? Why should not his science also derive benefit from this, his noblest capacity? The assertion which is so often made that revelation was never intended to be used in matters of science is a bare assertion, to say the least an insult both to God and man. Revelation, as the term itself imports, is the *unveiling* or disclosing to the intellectual eye, something previously veiled or covered, and this by the direct agency of the Divine Being. So also is all true discovery, *an uncovering* made to man by the Divine. We have heard it said that reason ceases where revelation begins; but this cannot be, if reason is, as I conceive, the faculty of the mind which enables us to see causes or *reasons*. Reason is silent I grant where blind belief begins, but such is scarcely the dawning state of revelation, which is in its perfection like a bright unclouded day disclosing all things. Men of reflection are aware of this. In the world we perceive that the time is come for science and theology to embrace each other, for righteousness and peace to kiss each other; hence we have seen a Dr. Stanley, even in our own city, publicly urging his reverend professor to pursue his course of scientific investigation. Joyful contrast this with the time when the theologian and the natural philosopher were distinct. When, as in the case of Galileo, it was considered necessary to interdict the professor of the one for meddling with the other.

Commencing an examination of the external world, its vastness at first overpowers, and we believe the work insuperably beyond us. Like children we look at every thing as infinite, and ourselves alone as limited. If we would tell the stars in the firmament we are baffled. If we would divide a grain of sand to its ultimate atom we cannot do it. If we would limit the celestial spaces, or reckon when time began, imagination fails. This is the first impression. Shall we doubt it, or shall we believe creation to be infinite? Let us pause a moment. We have seen as much infinity in a grain of sand in its minuteness, as in the starry heavens in their greatness; the limit of existence escaping us in either case. Shall we bow down to a grain of sand merely because we cannot see its limit? the mind

revolts at such base homage, and inclines to think the objects it beholds are rather the work of ONE alone the infinite, and themselves but a resemblance of His infinity. And in this feeling it rests at length, and veneration flies from the object of sense, satisfied by reason; for myriads of units cannot make infinity, though the infinite can and does make myriads.

Satisfied with this conclusion, the mind feels lighter for its task. The vast less incomprehensible. It is true we cannot count the number of its objects. Suns, worlds, or the leaves of trees are alike innumerable. But we view them now in their aggregations, only as an imitation of the Infinite, shewing his power and glory; and we contemplate them singly and by themselves. This is the advantage we reap from carrying our higher principles into scientific investigations. We dare now hope to learn yet more and more of nature's works approaching perfect knowledge. No clue however which will assist us in her labyrinths must be neglected, nor any information tending to untie her gordian knots. Each object even simply viewed presents affinities and analogies more than a match for the most comprehensive mind we have yet witnessed; although every succeeding year brings with it greater light, strengthening our hopes that the time may come when the great promise will be accomplished, that there shall be nothing which is hid but what shall be uncovered.

The ancients held that the symbol of perfection was *a trine*, and Egypt handed down this their opinion in monuments truly more lasting than brass—the giant pyramids! The Hebrews and Eastern nations filled their writings with the number 3, to signify the same. Greece and Rome also shew their furies, fates, and graces complete in three. And in the present day Christian Europe uses the triangle as its holy emblem. We ask is this idea, so long all but universal, a mere chimera, or a poetically illustrated fact: and longing both ourselves and others after the perfect, we examine into its details. In a philosophical as well as a scientific point of view, the subject has lately occupied the mind again. Ethics and physics have been shewn to bear it out, and we find the ancients with just cause boasted of their sages!

A determining *will*, an efficient *cause*, and a *result* thence proceeding was alike taught by a Pythagoras or a Plato to be the essential requisites to make a perfect work. And every modern of interior thought welcomes the doctrine as the truth, thus shewing that perfection depends on the supremacy of mind. So also stability, for whilst the intending end makes one with the end perfected, involving between them the efficient cause, the trine complete is indestructible. Generally men now see no further than the cause, which in physician's language is designated as proximate. Proximate causes the profession styles the amount of their usual perception in causation, well knowing that they discover but half the mystery, and the principal is yet remote.

End, cause, and effect, being necessary parts in every perfect work, we look for the same in all creation, whether man or otherwise. We look not only on each object, but on the whole, and every part as a triunity containing within itself the three degrees. And we do not look in vain. The grandest of all sciences has displayed itself. The arrangement of the world has been discovered. With artificial systems the day is past or fast departing. Immortal in minutiæ and detail, Linnæus and Cuvier may be, and doubtless are; but in arrangement saving as indexes, their theories ere long will be laid aside.

The ancients described the grand trine of creation under the significant terms celestial, spiritual, and natural; teaching that will variously called desire, feeling, and soul, constituted the first or chief—the intending end for which all else proceeding operates; thought, instinct, perception, and their varieties, the middle or means whence the effect springs; and form, arrangement, external manifestation or developement, the last—the perfected end or the result, whence we derive our term *nature*, which can never be correctly applied only with reference to effects, for in the constitution of human language the word nature is of a passive signification, being derived from the latin *nascor*, to be born or produced. The same also may be said of material, derived from *mater*, a mother, or one who bears. In the effect or natural, ALL is rendered visible in the supremest grandeur and magnificence. And yet with all her wondrous beauty, Nature is but the last or lowest portion of the whole.

We must not be captivated to view her but as the handmaid of the trine. Feeling and thought were not made solely to the intent that nature might exist, but rather nature was created that feeling and thought might have their being and developement.

Adopting this division as the most comprehensive ever offered for universal arrangement, its investigators have lately discovered that each grand division of the mighty trine is itself a trine, again subdividing, and again—circle within circle, wheel within wheel, as can be fully demonstrated. Also each division down to its minutest compartments has been found to bear the double relations of affinity and analogy* with every other. The first with the second, and these with the third, and each with all, defying and baffling the powers of the human mind to follow in the circle—nay, the vortex of imperceptible yet perfect finish thus assumed.

> "Where ends this mighty building? where begins
> The suburbs of creation? where the wall
> Whose battlements look o'er into the vale
> Of non-existence? Nothing's strange abode!
> Say, at what point of space Jehovah dropp'd
> His slackened line, and laid his balance by;
> Weighed worlds and measured infinite no more?"

It is in connection with the above theory that I now purpose shewing man's physical constitution with reference to an external world. By this arrangement man should possess a three-fold order in himself as well as nature, and all nature in her lowest forms should be a resemblance of her superior orders, and hence man, *the sole type* (as he is the loftiest object) of the whole. To view man in this light—the lord and master truly of the finite world—I purpose first a glance at external arrangement, and secondly at organization and structure, confining myself at present to the third or natural division of the universal trine. The astronomy of the subject I shall entirely omit, the sun being emblematical of the infinite rather than of the finite creation.

By virtue of the relations which each division of the trine bears to each other, each is as I before stated itself a trine.

* The relation of affinity is the relation of cause and effect. The relation of analogy or correspondence is a resemblance between causes or effects.

Nature is a trine of *animal, vegetable,* and *mineral.* The animal bearing relation to the first grand division which is will, the vegetable to the second, and the mineral to the third. The mineral kingdom, fixed and inanimate is the type of Nature herself, both thirds in their respective trines. Of man's structure we shall presently shew this trine of nature is but a resemblance.

Externally viewed the human frame is composed of three distinct parts called head, chest, and abdomen, with their extremities, to one of each of which parts severally belongs the organs of animation, growth, and reproduction. Externally viewed, man is also of three distinct species, called Caucasian, Mongolian, and Ethiopian. With some, the differences between these races are merely called varieties, and attributed to accidental causes, as climate, food, &c.; but the red, white, and black skins are not thus to be produced. Let the Spaniards settled for more than two centuries among the copper coloured Indians of Mexico and New Spain, the Dutch boors of Southern Africa, the descendants of the whites who first settled in the West Indies, and above all the Jews, now scattered amongst every nation under heaven, bear us witness.*

Again the Ethiopian as a distinct species, presents in itself yet other three species. The Ethiopian or African Proper, the Malay, and the American, with whom we trace analogies with the Caucasian and the Mongolian. The American in the West resembling the European Caucasian, and the Malay in the East the Asiatic Mongolian. This second minor trine so manifest in the third division of the great trine, I would here observe, is the case throughout this whole arrangement, and it happens by virtue of the first and second divisions of the trine each forming their resemblances as effects in the third. It is thus also that Nature which is herself but a third division or an effect so immediately manifests her three kingdoms.

To illustrate the three kingdoms of Nature. Behold in the first class of the first kingdom, namely the animal, the three divisions. In the first order, vertebrated animals, walking on the earth in the majesty of strength; in the

*Swainson. Vide "Geography and Classification of Animals," by Wm. Swainson, Esq. Lardner's Cyclopedia, Page 2.

second, soaring through the air in their pinioned flight; and in the third, darting through the deep with their finny sails. Then look on the second class and its divisions. First, wingless insects running on the ground; secondly, the whole insect tribes, the type of their class, swarming the atmosphere; and thirdly, the articulated crustacea, crabs, barnacles, and the cirrhopoda generally, inhabiting the ocean. And lastly, regard the third or lowest animal class and its three divisions, the mollusca, or shell-fish tribe, the acrita or polype, and the radiata, with the star fish and sea urchins, corallines, animalcules and infusoria—strange creatures of the waters! Here life is fast verging toward its confines. Animation, feeling, and growth, fast departing. Form least glorious, but apparently most endless in variety; for as in all third classes representation is here at her busiest work, the circle of effects shadowing forth all the upper grandeur of the great foregoing. In the words of the poet:—

> "Mellowing the landscape, and crowding the stream,
> With shadows that flit like a fairy dream."

You will observe each trine in the above arrangement refers to the great mineral trine of solid, aeriform, and liquid. The first containing the terrestrial animals as its *type*, the second, the winged, and the third, the aquatic. In this third again, behold the minor trine which I have already pointed out as most apparent in the third. In the aquatic order of vertebrated animals, (animals with a spine and bones—similar to man,) we find the reptiles in the first place, and fishes in the third. The animals of the second are scarce. The greatest part most likely extinct. Flying fish, and if travellers are to be credited, flying serpents, would help to fill up the gap, with perhaps the now fabulous dragon. In the aquatic order of articulated animals, (animals whose body and legs are jointed and the hardest part on the outside, as insects,) crabs, lobsters, and crustacea generally, constitute the first class. Vermes, including the flea and other vermin, which if they do not fly very closely imitate by their prodigious leaps, the second class; and barnacles and lepas, fixed to the bottom of ships, posts, and piles standing in water, the third. In the grand aquatic or third division of the grand trine, the minor trine gives us star fish, with backs

resembling vertebræ, for the first class, animalcules as the second, wherein if the microscope speaks truly we have winged monsters in abundance, and corallines, resembling the barnacles of the last mentioned trine, for the third.

This outline of the animal trine for the present must suffice. In the circular system of Mac Leay further views may be seen on the subject. Lamach originated the idea of similar arrangement in studying the invertebrated animals. Mac Leay in zoology generally, and Fries in botany, have principally worked it out. Those who are curious and unacquainted with their labours, I would refer to Swainson's Classification of Animals, Lardner's Cyclopedia.

The exquisite finish, form, and beauty of the whole however yet remains to be shewn, which consist in the relations of affinity and analogy every part bears to the other through all creation—

> "Each to all its being leuding,
> All on each in turn depending,"

to use the words by which I alluded to this unending harmony in my last lecture. One moment let us notice. The quadruped of the earth does not stand alone. No. It wings a class of its own, and joins the birds of the air; and amphibious, plunges in the main. The birds of the firmament do not stand alone, they find relations in the flying fishes of the sea, and join the quadrupeds in the winged mammalia. Thus also it is evident neither are the fishes isolated. One and all they form a circle of infinite imitations. Innumerable are their relations of affinity and analogy already discovered! The great circle vertebrata, so pre-eminently terrestrial, does not stand alone. Its forms are all again renewed in the second circle, pre-eminently aerial; and in the third, almost entirely aquatic, both are yet a third time created. In all, the circle of affinity and analogy is perfect! The great animal kingdom itself does not stand alone. It is bound by the closest laws of correspondence to the vegetable, and the mineral is similarly added to both. The vegetable kingdom possesses its trees and woody plants analogous to the vertetrated animals, with sap like blood circulating through their vessels. Endogens like insects, (witness the orchis tribe,) form the second

class,* and fungi, lichens, and sea weeds, the third; each, a division of the minor trine ever conspicuous in the third. And the mineral kingdom fixes and confirms this wondrous whole in its mighty regions of earths, atmospheres, and waters. In this vast—interminable—unmeasurable—unfathomable, we have first the shining metals and the soils; secondly, the wide spreading airs and gases; and thirdly, the fluid masses, and the deep. The solid, the aeriform, and the liquid. The liquid presenting us again with the minor circle resembling the prior orders—the dense liquid metal—water—and the light attenuated alcoholic fluid.

Considered with reference to anatomy and physiology as well as in his more external relations, man is also the centre and the great type of all. The artificial methods of placing him at the top of a chain, each link a being beneath him, will not answer to nature's evidences in either respects. If we could even bring our mind to believe a monkey next akin to ourselves, we surely could not either externally or internally viewed think the eagle naturally follows the whale, or the opossum the seal, as they stand in the règne animal. Man anatomically and physiologically explored is the type of whom every other species of organization and function is but the resemblance. Thus internally explored, the threefold order is discovered to constitute his frame, and in imitation also the frame of all without and around him. This order consists of animalized, developing or growing, and re-productive organs. The sensitive, the vascular, and the re-productive systems. The sensitive system is a trine, the first trine of the three, and consists of organs of sense, motion, and nerves. In man its centre is the brain, connected with the extremes by innumerable small thread-like bodies, constituting a most wonderful net work in its proceedings. In animals it is the same with great variety, becoming simpler and simpler as we descend from circle to circle through every grade of existence, as we shall presently shew. The developing system or organs producing

* The analogy existing between the endogens of plants and the articulata of animals is further most strikingly and familiarily shewn by the bamboo cane—a giant illustration of the grasses generally. In the bamboo we have a hard external sheath called cane, enclosing all the soft parts like the horny coverings of insects. This sheath of hard parts is alike the characteristic mark of both these two grand sub-kingdoms—the endogens of plants and the articulata of animals.

growth, is manifestly the second trine from its similarity to the vegetable world, the second great kingdom of Nature, which subsists itself by methods resembling these organs. Growth is caused by a perpetual circulation and movement performed in countless myriads of blood vessels, supplied with nourishment from without, and exhausted by a variety of excretions continually passing outwards. The organs of waste and supply together with those of circulation constitute this trine. In animals this system is universal with great variety, and it principally constitutes also the vegetable, as I before observed. Viewing the arteries and veins separately, the analogy between the two kingdoms is most apparent, their ramifications and branches cannot fail to remind us of trees and plants. The third trine is formed of the wonders of reproduction, where all is again represented, and as in the vast storehouse of universal nature—the mineral kingdom, perpetually maintained. In the reproductive system the first principles of nature are organized to subsequent use. Like the foundations of an earthly temple, which in time is reared, step by step, till the keystone of the whole is added, and votaries throng its courts with joy and praise; so is the great temple of the universe, whose deep foundations are laid in the third circle of the trine in all its gradations, first in the mineral, secondly in the vegetable, and thirdly in the animal: and to what end? To this—that man, the keystone of the whole may live an organic being, whose soul of life and voice of praise is thus fitted to fill all, and resound throughout the whole to every vault of heaven!

To demonstrate the truth of this arrangement I will now give a brief account of its two first great divisions, as exhibited in man and the animal world. And first, the sensitive system, consisting of nerves and organs of sense and motion. The first of these, the nervous system, is composed of brain and cerebral nerves, spinal cord and spinal nerves, and sympathetic nerves and ganglions; each of the three parts distinct, yet all comprising one grand whole; all to be found in man and the first great circle of animals—*animalia vertebrata*. The cerebral and spinal nerves with but a vestige of a brain and cord, alone are found in the second class, the *animalia articulata*. And in the third, ganglions and sympathetic are all that are discernible, and even these seen with difficulty.

The brain is largest in animals and birds, small in reptiles and fishes. In reptiles and fishes however the cord is very long, the vertebræ in the boa constrictor is composed of more than 300 pieces, and in the shark they exceed 200. Many of these animals can live for a length of time without a brain, as the turtle and the common eel. In mammalia and birds the brain is continually requisite to the support of life. The brain is a soft, whitish, pulpy looking mass, whose organization we shall particularize as we proceed in these lectures. It is enclosed in the upper and superior part of the osseous frame called the cranium or skull. Its nerves proceed from its base to the organs of sense through numerous openings in the skull. The spinal cord, vulgarly called the spinal marrow, and the sympathetic nerves also appear connected with it, the first joined to its base, the second connected with its sixth pair of nerves. The function of the brain is to present sensuous impressions to that degree of life which we call animal and is possessed by the higher animals in common with ourselves. This seems to be effected by certain movements and oscillations in the brain caused by the impression made on the sensual nerve, which movements in their turn excite corresponding volitions or spiritual movements in the life, perfectly in harmony with the material movements. With those animals who have no brain the sensuous impression of the nerve alone informs the life, which in such animals is considerably less powerful and multifarious than that of the higher classes.

Phrenologists say we are indebted to this organ for the faculty of thought; and as far as thought is induced by sensation and external impressions so we are, and so is every animal possessing a brain in common with ourselves, but no further. Such thought however is but the basis of the deeper faculty of reflection and inspiration possessed by man. Man has a superior developed brain to any animal, enabling him the more perfectly to recognize the greatest variety of external impressions. Nay every variety of sense is the property of man, whereas each animal excels only in some particular kind. Man's superior movements which no animal can imitate also appear to commence in the brain.

The spinal cord and its nerves, according to the researches of Sir Charles Bell, seem to be as peculiarly adapted to influence the organs of motion as the brain and its nerves are

o reeeive the influence of sense. This system is aecordingly n aeeompaniment wherever brain and the organs of sense re found, and the spinal cord vanishes from the animated heatre of ereation at the same point where the brain disppears, the nerves alone remaining to keep eompany with he nerves of sense also similarily destitute. The funetions of both these nerves we shall presently eonsider, speaking of he organs of sense and motion. The sympathetic system of nerves extends through the whole animal kingdom, alone when every traee of brain and eord, sense and voluntary motion have departed. The sympathetie is found in the fœtus commeneing with the strueture in its first beginnings. t is perfect in acephalous infants which have been born vithout brains or spinal eord, plainly shewing it does not originate in those organs. It may justly be supposed to be he seat of that pleasurable sensation which existenee imparts o all of us independent of any distinet cerebral excitement. In the lowest forms of erustaeea and mollusca this is the nly life enjoyed by the animal. It is not until we come to he eirele aerita, comprising the zoophytes, and radiata, omprising the animaleules, that we fail to diseover these erves; and here we may perhaps fail from want of means to iseern, and eannot possibly say that they or any form of nimal life are destitute of nerves.

We now eome to speak of the organs of sense. These are ree in number. The sense of hearing, sight, and touch. The sense of toueh again as the last and most universal of he trine dividing into taste, smell, and touch, generally so alled. Of these the sense of hearing is the first we shall otice, being the least common of the three in the animal ingdom, like all the highest faculties, and those of the premest if not of the most universal use to man. The ost universally neeessary organization we always find the ost universal in nature, the more exalted the most exclusive; ut all in man. Without this eriterion we might hesitate to eeide a preference to the senses, so much we value each. Thus we learn whieh is most eommonly neecssary, whieh is ost exalted in its use. The ear is the most perfect of coustic instruments offering membranes and fluids to reeeive he coneussions of the air, reverberating and concentrating s undulations till even a whisper is made audible and

distinct to its listening tenant. Nowhere more than in the contemplation of this organ, as also of the eye, does man see more complete evidence of design, or is better enabled to appreciate the Almighty wisdom which framed us; inspiring us to exclaim with the psalmist—"He that made the eye, shall He not see? He that planted the ear, shall He not understand?"

In man and mammalia the ear always contains a cavity which opens internally into the mouth by means of a tube, and externally is headed by a membrane which makes it like a drum. The cavity is hence called the tympanum. The opening into the mouth the eustachian tube. Besides these we also find semicircular canals and other complicated apparatus. The whole is carved out in the stoutest portion of the skull bone, and surmounted by that fleshy appendage which we commonly call the ear, and which seems to serve as an ear trumpet. In birds the external ear is generally covered with feathers. In fishes the eustachian tube is deficient. Articulated animals mostly seem to possess this sense, and in some the organ is found, but not generally. In insects, entomologists have supposed the organ to consist of small openings which they often discover in the trachœa. The cephalopoda or sepia tribe of mollusca, many of them have an ear, but generally mollusca and all inferior orders are destitute of this organ.

The eye is more universally found than the ear. The eye is a perfect optical instrument, adapted to the transmission and concentration of light to a focus by means of lenses more transparent than glass. These lenses as possessed by us as well as quadrupeds and birds, are three in number. Their relative sizes constitute the varieties of long and short sight. After passing through them, the rays of light finally form a picture on the nerve spread out at the back of the eye to receive them. This nervous expansion is called the retina. As the second sense of the trine, sight is possessed in its greatest perfection by birds, the second class of the first great circle; and by insects, the type of the second great circle. The rapacious bird on the wing will stoop to his prey at distances we could scarcely conceive any object could be visible even to an eye at rest. Insects have compound eyes, that is a number clustered together

looking all ways. They generally possess three clusters placed in a triangle at the top of the head, besides simple or single eyes. Others of the articulata, as the crab, and some mollusca, as snails, have their eyes placed on moveable pedicles, giving them great latitude in using the organs. In articulata, even the annelides or red blooded worms, as the earth worm, have black specks which we suspect to be eyes. In mollusca, the shell fish, which are its great type, have neither eyes nor ears; but we find in the second class of beings far below these, as the hydra amongst polypes, a sensibility to the action of light, and a seeking after it, although the animals seem to possess nothing but a sac and tentacula around it.

The sense of touch is most universally enjoyed by animals. The highest faculty of this sense seems to be *smell*, and it is the least common. Smell is a greater blessing to us, seizing on the odoriferous particles of the atmosphere, pleasing and disgusting, than many are at first aware of. We find out its immense importance when we remark it is the instinct which enables animals to choose their food. In most quadrupeds the nostrils are large. In birds the organ is concealed at the base of the bill and is extremely sensible. In fishes the olfactory nerves have ganglions at their base. Their nostrils are simple cavities at the end of the muzzle. In insects no organs of smell have been discovered, but it is supposed by some that they possess the faculty at the end of their antennæ. Of the mollusca, Cuvier says, "No particular organ of smell has ever been detected in them, although they enjoy that sense. It may possibly reside in the entire skin for it greatly resembles a pituitary membrane." This we should expect in the third circle of the great trine.

The sense of taste resides in the nervous papillæ of the tongue and palate. In mammalia the tongue is very fleshy, in birds not so much so, but always large. In reptiles the tongue is very various. In some, as the tortoise, short and bristled with fleshy filaments; in others, as the lizards, and serpents, long and forked. In the frog it is attached to the edges of the jaw and folds inwards. In fish it is chiefly osseous, and frequently furnished with teeth. Insects, with jaws fitted for triturating their food, have a tongue continually adhering to the lower lip. In some it forms a sort of

proboscis. In mollusea, salivary glands are eommon, warranting the supposition that they enjoy taste although they do not seem to possess a tongue.

The sense of touch is the most diffused of all the senses, not only individually but universally throughout the animal kingdom. Perhaps no animal form is destitute of it. It is the last sense we have to eonsider in this arrangement. In its universality it seems to enter into the vegetable kingdom. It is most delicate in the extremes of our bodies as the finger and toes, and appears most exquisite in the lower animals. In inseets it crowns the head in its perfection in their antennæ, and the naked bodies of the mollusca appear all touch.

Having thus briefly treated of the nervous system and the organs of sense, I will now as cursorily as possible, (for our time is passing,) notice the organs of motion, and proceed to our last subjeet for this evening—the great system of growth. The external frame of bones, muscles, and integument or skin, constitute the organs of motion. The arrangement of the bones gives the human form to man, as a glance at the skeleton presently shews. In man this form is erect and exquisitely adapted in every particular to the most delieate movements, as the dancing master and gymnastic adept fully exhibit. The vertebræ are composed of three distinct parts called cervical, dorsal, and lumbar: the caudal in animals is an extension of the lumbar. The extremities, arms and legs, are also formed of three bones the last of which again subdivides, forming the hands and feet. Here, in the hand, we have an admirable example of the trine. The thumb, the fore-finger, and the three others compose the trine. The thumb and fore-finger are the most important. Consider for a moment the strength and security given by the thumb to every office which the hand performs. How weak would be our grasp, how unsteady our writing, how insecure our handling, if we were unfortunately deprived of this member. The fore-finger is nearly as important. It acts in unison with the thumb, and is only inferior to it in strength and utility. The three long fingers join their central one to the fore-finger and the thumb. The little finger, though so diverse in power, nearly approaches in use, and is the same in length to the thumb

nod on being brought to it, forms the whole into a circle. n this posture singular are the analogies of the hand to the reat kingdom of Nature. Look at the first division. uadrupeds, in bulk and perfection resemble the thumb. irds, in their ranking next to quadrupeds, resemble the re-finger. The longest of the vertebrated animals, the rpents and the reptiles, the middle finger. The fishes, e furthest removed from the quadrupeds, the little finger; ithout feet, and comprehending the smallest of all the rtebrata, yet joined to the quadrupeds by dolphins and hales. Let not this familiar illustration appear trifling, I rrow it from nature; and a great author,* whose words I early quote, has used it before me.

In quadrupeds, the bones very nearly resemble our own rrangement, the fore-feet answering to our arms, which is parent when we see a dog or a monkey resting on the nd legs. In birds, the bones of the arms are still perfect— m, fore-arm, and hand. These are covered with feathers, d constitute the wing. It is the thumb which furnishes e bastard quills. In fishes, the limbs grow very short, d rude representations of fingers and toes support the embraneous fins. In reptiles, legs are lost as we approach e serpent, in which however, rudiments are often found. ones seem to become extinct in the first great trine. The rd parts of articulata are rather integument or skin than nes. They are hard and horny envelopes in insects, and ustaceous or shell-like, in crabs. They are all external of e muscles like the skin. In form the insect mostly ssesses six or more legs as well as their delicate antennæ d wings. This multiplication of extremities looks like an timate effort of nature to redouble herself before she folds in the shell of the murex or the triton, or floats a jelly- te substance on the waves, as is the case in mollusca and e polypes.

The muscles, as I stated in my last lecture, are bands of sh passing from bone to bone, composed of a number of res, each of which receives a nerve. These, when influenced the nerve, shorten their length and thus move the position the bone attached to them. Thus, man, and every animal dowed with locomotive powers, move from place to place.

* Swainson. "Geography and Classification of Animals;" page 324.

Hence, muscles are found in every animal capable of motion arising from internal energy. Animals solely moved about by the agitation of the waters, as the medusa amongst radiata, alone are wholly destitute of muscles. All those parts we commonly call the flesh of animals are muscles. It is by the action of the muscles on a peculiarly constructed organ at the top of the windpipe, that the human voice, the bellowings of beasts, and the songs of birds, are produced.

The integument or skin in man and the great animal trine which first surrounds him, is a net-work of blood-vessels and nerves, imbedded in a soft tissue, and covered by a delicate transparent membrane called the cuticle, or scarf skin. With us this structure is unadorned by nature, saving on the head, and at the fingers and toes, where hair and nail are added. Every animal, however, is clothed, each with its own appropriate robe. It is a nice question to ask why this difference is made, and it is a glorious answer which the truth gives. Man is *thus*, evidently that he may be in every respect the universal *type* of all, and in his turn appear somewhat in the resemblance of each. As a king, he puts on such a stately robe, and decorates his brow with so rich a plume, taken from earth's costliest treasures, that no animal however noble in his class can rival him for ornament and splendour. As travellers, thus we are enabled to range from the tropics to the poles at pleasure, and suit our dress accordingly. Muffled in hides we outstrip the shaggy bear—clothed in silk, the sleekest of the feline race. Morally man thus exhibits his poverty or riches in the eyes of his fellows; and a new light opens on the subject independent of the world. The skin of the animals is mostly clothed. The beasts with fur and hair, the birds with feathers, fishes and reptiles with scales. In the second class, further apart from man, the clothing begins to cease. Though the scale appears in the bright diamond-beetle, and the hair and down on the caterpillar and the butterfly, the naked worm appears. In the third, Nature again lays by her mantle. In her remotest regions, flesh-like she leaves her forms resembling in her ultimate creatures the skin she made for her *first*—CHIEF WORK.

To conclude these few observations on the sensitive system—the first great trine peculiarly animal. Nerve

ense, and animal movement, ever hold a harmony between
nemselves. Is the life timid, gentle, and harmless?—the
erve is tremulous, the ear is active, the legs are slender,
nd the hoof is clean. Is the life bold and savage?—the
late is large, the limbs are thick, the claws are strong.
it treacherous and cunning?—the eye is piercing, the step
stealthy. Sagacious?—the foot is firm. Brutal?—the hoof
slovenly. And man is somewhat more than allegorically all
is. Man is, as we have seen, adapted to the vast theatre
nature, (in his sensitive system at least,) by virtue of his
pical character.

Growth, production, and waste, causing again growth and
oduction in a perpetual circle, constitute the second or
egetable trine of the great world of nature. With a few
servations on this we shall close our subject, the vastest
subjects, yet omitting its widest though least sublime
anch, the third trine, wherein the wonders of reproduction
concealed. For the present we must be satisfied with
erely a glance at the second. The vegetable trine belongs
animals by virtue of the law, that every superior possesses
its inferior has, and somewhat besides. A law we have
en and pointed out throughout all our previous observations.
ne system of the blood, of repletion, and depletion, (as we
ll call them,) constitute this trine. The theory of its
tion is as follows. The living body is one constant vortex
motion. Slowest at the points apparently fixed and solid,
st rapid in the streams commonly called the circulating
ids. This can be demonstrated by direct experiment.
ne life of sensation resides in the nerves, that of organi-
tion in the blood, or vegetable sap, as the case may be.
ne life of organization, ever demanding fresh material
ilds up the structure. This also can be demonstrated.
ne structure thus built up must never continue stationary,
circulation would be stopped, and life deprived of a suitable
ode; hence the structure is as continually circulated back
ain to the blood, as it was built up by it. This is effected
the absorbent system. The matter thus returned, however,
unfit for further use, and must be rejected. This is effected
glands secreting it from the blood, and apparatus throwing
without the body. These are the actions of the secreting
l excreting systems. Blood, vessels, and structure thence

produced, constitute the system of animal growth and development. In man, mammalia and fishes, we have three distinct circulating bloods, red, dark purple commonly called black, and white, each circulating in different vessels. In such a circulation, the blood and the whole animal is warm. In reptiles and fishes the red blood is wanted; the two latter alone constituting the circulation. These animals compared with the above are cold. The annelides or red blooded worms alone possess red blood amongst articulated animals. In insects the circulation is wholly white. In mollusca we have often a faint pale purple one. The system which propels and circulates the blood consists of heart and vessels. The vessels are distinctly of three kinds; arteries, veins, and capillaries. The heart also is a compound organ. In most of the higher animals and in man, the heart, properly so called, is composed of two parts, an arterial and a venous heart in close proximity. In reptiles we have only a venous one. In the second and third grand circle of animals, we seldom find any heart; where we do, it is mostly single. The heart propels the blood by continually opening to receive it on one side and shutting up its volume to expel it on the other. Besides the heart, the arteries also have a power of circulation, expanding and contracting successively on the blood, as may be felt at the pulse. This power is concentrated in the spleen, where an accumulation of large arteries act in conjunction on the blood, forcing it to the liver. This organ, in addition to the double heart in the chest, may properly be called a third heart in the abdomen. The pulsations of the spleen are felt on violent exercise on the left side of the body directly below the ribs. Of the vessels I shall now merely observe that the arteries carry the blood from the heart to the extremities of the circulation, and the veins return it. The capillaries are minute thread-like tubes springing from the arterial trunks, and pouring out the blood into the adjacent parts, in the form of matter similar to those parts, be it nerve, muscle, vessel, or bone. In the lower animals the whole circulation appears to be capillary.

The system of repletion, supplying nourishment to the body, is of three parts. Organs adapted to the digestion of solids, airs or gases, and liquids. The first is performed by means of an alimentary canal, the second by lungs, and the

third by the absorbents of the stomach. The alimentary canal in man and the higher animals, is composed of organs of mastication, where the food is broken up into fragments and mixed with saliva in the mouth; organs commonly called digestive, or the stomach, where the food is converted into an homogenous substance called chyme, by mixing with the gastric juice; and organs of chylification, or the bowels, where the preparation of the food for replenishing the blood is perfected, when it is called chyle. This third apparatus is further divided into three, bowels, mesentery, and thoracic duct. The first separating the chyle, the second taking it from the bowels, and the third conveying it to the blood.

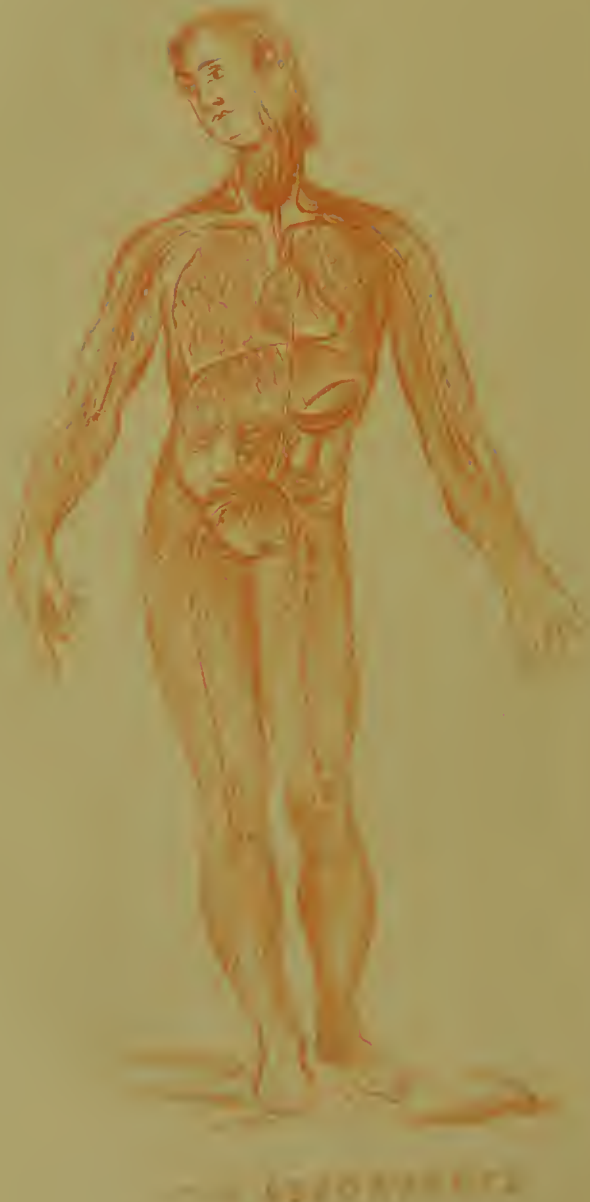
In respect to food man is omnivorous, even cannibal in the uncivilized state. Mammalia presents animals also omnivorous. Her noblest specimens however are graminivorous; and it is a question in the mind of many a philosopher, whether man would not be nobler also than he now is, if he lived entirely on vegetable food. The fact of his having canine teeth, and a stomach evidently partaking of a carnivorous character, only shews that nature is adapted to his desires, and does not prove that those desires are any credit or ornament to his character. In fish we find the greatest variety of teeth, and most frequent want of them, some being unable to swallow any but liquid food. Birds mostly grind their food by means of a horny substance which lines their mandables. In articulata, insects mostly live by suction. Some, however, as the coleoptera, appear to grind their food. In mollusca, all kinds of digestion, from the most simple to the most complicated, are found. In acrita, or the polypes, we have mostly a mere bowel as it were, into which the food is swallowed up by suction.

The organs of respiration in man, are trachea or windpipe, bronchi, and air cells, composing the lungs. In these cells, the blood circulating in the lungs meets with the air, separated only by a thin membrane, capable of maintaining the blood in its course, but allowing the air to permeate it, and so enter the blood. In mammalia, birds, and reptiles, respiration is the same. In fishes, the blood circulates through innumerable vessels composing the gill, through which the water freely passes. The air contained in the water is thus brought in contact with the vascular system of the gill, and

enters the blood. Out of water, fishes die from the gill becoming dry, and incapable of the action of respiration, which continually opens the gill to receive the air of the water. In some however, as the eel, the gill is so protected as to prevent this drying and closing up of the organ from taking place. Here the structure approaches to the bronchi of mammalia. In amphibia nearer approach yet is made, part of the organs being branchiæ or gills, part bronchi or lungs. In some malformations of the human body, branchiæ have been found opening the trachea or windpipe into the neck. Insects and birds respire more freely than any other animals. The trachea of birds is very long, and insect respiration appears performed nearly entirely by means of trachea. In crustacea and arachnides, spiders respire by means of lungs, and crabs by means of branchiæ. The annelides or worms respire variously. The mollusca are mostly supplied with branchiæ. The acrita are mostly destitute of any organs of respiration.

The method of digestion of fluids is much disputed, many physiologists consider that it is performed by the liver, the fluid being carried directly from the stomach to the veins, and thus to the liver. It appears to me however most likely that fluids directly enter the blood for the purposes of circulation as they leave the stomach, from the coats of which they are taken up by lymphatic vessels. By experiment we find that fluid does not pass into the intestines, but escapes the stomach by its coats. Besides the liver never seems particularly influenced by fluids, as we should suppose would be the case if it were adapted for this function. All animals seem to digest fluids, and some nothing else. Many fishes are incapable of swallowing solid substances from a peculiar organization of gullet. Most insects live by suction, and the lower forms of mollusca and acrita, the lowest of animals, entirely so.

The last system which we shall notice this evening, is the system of depletion, consummation, or waste. As the third of the trine it is complicated, and hence can receive from us on this occasion but a very brief survey. Its functions are composed of three distinct parts, the absorbing, secreting, and excreting organs. The absorbents of this system, commonly designated lymphatics, from their carrying a colourless



iid like water, are innumerable capillary vessels, arising
om every point of the solid structure, and running in every
rection to the blood, which they enter all together, forming
e terminating vessel for this purpose. Their action is to
ep up a perpetual circulation, continually removing old
rticles as the blood deposits new ones. This action is
aintained by small spongy bodies, possessing a power of
ction, attached to every absorbent vessel at short distances
rough its course, giving it a knotted appearance. Every
imal possessing a circulation of arteries and veins, is
ovided with absorbents. In those in whom capillary action
one seems going on, as in the insects, and the radiated
imals and polypes, actual absorbent vessels have not been
scovered.

The secreting system is the appointed means for removing
is old matter, thus introduced into the blood, into vessels
d receptacles fitted for its expulsion from the body.
nder this definition, I restrict the secreting system rather
ore than is usual in ordinary classifications, viewing such
rmations as saliva, gastric juice, synovia, mucus, &c.
mmonly called also secretions, as necessary parts of the
during whole. Their difference in every respect from
e secretions of waste which we are now considering is
parent. The secretions of waste are distinctly carried on
three different parts of the body. In the chest, the lungs
parate carbon in a gaseous form. In the skin, vaporized
ids are continually germinated. And in the abdomen,
rfect fluids. In this last region the secretions are triple.
ne first from the pancreas, second from the kidneys, and
rd from the liver. The separation of carbon from the
gs is evidently performed only by man and the higher
imals. The excretions of the skin are carried on with
t little activity in cold-blooded animals and fishes, which
mostly covered by a gelatinous-like substance. Of the
dominal secretions, the pancreatic is large in birds, and
it of the kidneys small. In reptiles and fishes the kidneys
full sized. In articulata, hepatic vessels are nearly
nstant, and a liver is mostly found in mollusca. The ink
the sepia, and the purple dye produced by many shell-
h are secretions of the liver. Between the liver and the
gs there is the most evident and invariable correspondence,

shewing the relative value of each as secreting organs Wherever we have lungs ample and large, the liver is small, and vice versa. Insects have merely a few hepatic vessels, scarcely deserving the name of a liver. With regard to the vessels which supply each, the lungs are supplied with veins directly from the heart, and the liver with veins directly from the spleen.

The excreting system is composed of the lining membrane of the lungs, the cutis or scarf skin covering the whole surface of the body, the gall bladder, bowels, and the bladder. These excretory organs are usually found wherever their corresponding secreting organs are present. That the excreting power of the skin resides in the cutis is evident from the fact of the abraded surface being unable to perspire.

To conclude, permit me once more to remark that these analogies manifestly shew, ONE ALMIGHTY to have formed both man and nature upon ONE UNIFORM AND HARMONIOUS PLAN.

NOTE. It has been suggested since the delivery of the foregoing Lecture, that I am somewhat original in the use I have made of the word Trine; but however this may be, I must beg the indulgence of its use, for want of a word of more common import to express my meaning. The license I have assumed to myself in being somewhat arbitrary, in respect to language, in many places, both in the foregoing and following lectures, arises, as all must clearly see, from the fact of my often entering on ground scarcely, if at all, trodden before; and this must of itself, I should conceive, be a sufficient apology, not only for the occasional introduction of an unusual term, but also for much which I feel I must necessarily have hazarded, as an original investigator of truth.

LECTURE III.

ON PRIMITIVE FORMATIONS.

MINUTE INVESTIGATION OF STRUCTURE PROPOSED, TO DISCOVER ITS ALITIES AND FUNCTIONS—PHYSIOLOGY, THE STUDY OF LIFE—LIFE D DEATH CONTRASTED—VASTNESS OF PHYSICAL VARIETIES—THE EN AGES PHYSIOLOGICALLY EXPLORED—THE BEGINNINGS AND IGINS OF EXISTENCE—FIRST FORMS—THE SPHERE, THE BASIS OF ANIC FORMS—FIRST MATERIALS—PRODUCTION AND REPRODUCTION HE INCUBATION OF THE EGG—VIVIPAROUS GESTATION—THE BLOOD TS ANALYSIS—COMMENCEMENT OF INTERNAL ANIMAL MOVEMENTS—H GEOMETRICAL FORM OF THE BLOOD GLOBULE—THE BLOOD ALIVE NIMAL HEAT—ITS PRODUCTION IN THE MOVEMENT OF THE BLOOD—NTANEOUS COMBUSTION—HEALTH AND DISEASE ORIGINATING IN BLOOD—THE PRIMITIVE ANIMAL TISSUES—MEMBRANE—ITS UNI-SALITY—ITS COMPOSITION—CELLULAR, FIBROUS, AND MUCOUS MBRANES—THEIR DISEASES—THEIR VITAL COMBINATIONS—THE LE ORGANIC MAN—MUSCULAR TISSUE—ITS COMBINATIONS—MUSCLE SE OF THE MUSCLES—SPECIFIC LIFE OF THE BLOOD, MUSCLE, AND VE—MUSCULAR IRRITABILITY—ITS WONDERFUL POWERS—NOT CTRICITY—DISEASED STATE OF THE MUSCULAR FIBRE—NERVOUS UE—ITS COMPOSITION—ITS ORGANIC COMBINATIONS AND USES—TINCT VITALITIES—UNION BETWEEN SOUL AND BODY—HYPOTHESIS CORRESPONDENCE OR HARMONY, AND THE SUPPORT AFFORDED TO IT H BY HEALTHY AND UNHEALTHY PHENOMENA—RECAPITULATION SUBJECT FOR CONCLUDING LECTURE.

In our last lecture we treated of the natural arrangement the various organs and systems of organs composing the man body, supporting our theory in favour of a three-fold er of arrangement by constant references to the animal gdom generally, as well as to the other two grand divisions nature, the vegetable and the mineral. I now purpose her exploring these organs, both individually and col-ively, particularly with reference to their *vitality and ction;* more minutely to investigate their structure, to correct ascertainment of the degree and kind of vitality n possesses, and the uses and functions each performs er its own proper vital influences. Keeping in view the

vast and sublime connections of our study, as previously set forth in our two preceding lectures, and the arrangement I presented to you in our last, I shall commence this evening more special details; examining objects as far as it is possible separately, for the sake of more minutely particularizing them. This however can only be done to a certain extent. We cannot without incurring the penalty of rashness and ignorance separate any part from its combinations. If we would tell the vitality which actuates, or the use performed, we must view each structure in its proper place, sustaining all its various relations. The organic frame is like no human mechanism, which we may take to pieces and put together again, satisfied when we have done so, we are perfect in its art. At the furthest in this way, we can do no more than barely note down where a part is situate, and what are its appearances in death. We must study it living as well as dead, if we would dive deep into its mysteries. Dissection and examination after death are constantly to be referred to the phenomena of life. So they become important—indispensable. Otherwise they are comparatively valueless. The frame living and the frame dead are so diverse that they can scarcely be said to be the same. The genial warmth and cushioned softness give place to icy coldness and stiff rigidity. The eye once filled with light is dull, even if the sun beam should be cast upon its very pupil. The arteries which sustained the living current in its full crimsoned stream, become empty, gaping tubes. The universal motion is stayed. The muscle which in life would comparatively lift a ton, in death is torn in pieces by a pound. In death all is quiet. The soft breathing has an eternal incubus resting upon it. The heart has for ever lost its power. The stomach, once so silently, so gently propelling its replenishing stores on to assimilation—the absorbents and secretions once so universally making way for the incoming nourishment, with an equally still and I may say solemn grandeur, in death are mere tubes and curious cavities. The nerves but white fibrous threads. The brain, a paradox and wonder, slit in sinuses and rolled up in folds, surpassing strange! Our study—the study of animal physiology, is pre-eminently a study of life, and we must investigate its subjects accordingly.

Before however we proceed to any minuter investigation or detail than has hitherto occupied us, there is besides, one other feature of the vast, which I have not yet touched upon, demanding our attention in this place. I allude to the continual variations and never-ending dissimilarity of the objects we have to notice. Not only are no two men like, but at no two periods of human life, owing either to the ordinary progressive changes of nature, or to the more extraordinary ones of disease, is any one single part of any one living body precisely the same, in vitality, structure, or function. We are all familiar with the picturesque description of successive natural change given by our immortal Shakespear. At first the infant, mewling and puking in the nurse's arms. Afterwards the schoolboy, the lover, the soldier, and the justice. Then the lean and slippered pantaloon; and lastly, concluding without teeth, without eyes, without ears, "sans every thing." Let it be also remembered, that in each of these stages, of infancy, youth, manhood and old age, the corporeal frame throughout, *internally*, as well as externally, is changed, and always changing. Of these changes, septennary revolutions are most striking, and have accordingly been constantly noticed. Such periods are professionally called climacteric. The child born at seven months is capable of independent existence. Another seven, and teeth are acquired. Another, and he begins to walk. In the seventh year the teeth are renewed. In the fourteenth manhood commences. In the twenty-first the full stature is attained. This completes the period of growth, the first triple septennial evolution of the body. Firm and comparatively stationary, the organization then endures till a second triple septenary of years is passed, after which general decay commences, terminating in another similar period; thus consummating the grand climacteric of the ancients, which perhaps now, as formerly comes nearer to the average of life than any other number. To each of these stages belong universal peculiarities. Such are the wonderful varieties of vital phenomena, that every instant changes their combinations. Immediately after birth the arterial pulse beats between 130 and 140 strokes every minute, and has not even at the age of three years decreased much below 100. At birth the blood seeks

a different circulation, flowing to the lungs and leaving the liver, which accordingly loses its relative size in the abdomen. The circulating system and the nutritive absorbents are very large, so also the brain and the nerves, which afterwards gradually assume firmness, and consolidating, diminish in volume. The infant's eyes are remarkable for size and their beautiful blue. The lenses are scarcely clear, and therefore can bear with a full dilated pupil, a strong and to us a dazzling light. The ears and nostrils are cartilaginous rather than osseous in their principal parts; hence weakly sensitive. The bones and muscles are soft, and the skeleton in many parts contracted. The juvenile period, especially at its commencement, *the adolescentia* of the ancients, brings with it most remarkable changes. The boy and girl take the place of the child. The thorax expands, the lungs enlarge, the voice suddenly alters, changing the acute for the grave, deep tone. The frame becomes firm and muscular. The cellular membrane fills with fat. The spine elongates, and the stripling shoots up, surprising his family. The second epoch of this period spreads and furnishes his frame by lateral growth, following the longitudinal. The wisdom teeth, four additional molars, are added. At twenty-eight, the growth is considered perfect. The *ætas virilis* commences. The meridian of life is attained. The duration of this period, the warding off decline, or the inducing premature old age, now chiefly depend on the habits of individuals. Arrived at manhood we pause to mark the diversity of the human structure. Some are sanguine; of soft bodies, fair complexions, light hair, quick pulse, free secretions; withal lively, volatile, and impetuous, disposed to vascular diseases, inflammations, scrofula, and hæmorrhages. Others are melancholic, the reverse of the former, of firm dry solids, swarthy complexions, dark and black hair, slow circulation; the victims of dyspepsia, hypochondria and mania. Intermediate of these conditions, we find many well marked varieties called nervous, bilious, and lymphatic habits. choloric and phlegmatic temperaments.

At forty-five the retrograde movement usually commences. Circulation becomes slower. Density increases. The skin becomes tough and wrinkled. The hair is grey. The joints stiffen, and the muscles are less elastic. The lenses

of the eye shrink. The spectacles are required. We are warned to remember the world is not our continuing city. Venerable years approach. The green old age passes into the sere and yellow leaf. The head becomes bald. The hair silvery white. The skin puckers and folds. The pulse beats 40 or 50 strokes per minute. The arteries contract, and the veins swell. The brain and nerves scarcely perform their functions. The time for further sensuous impressions and active volitions is past. The deed of to-day is forgotten on the morrow, but the memory of incidents long gone bye mostly remains, and now perhaps again present themselves for the first time for years, approving or condemning. The life to come thus appearing to commence even before the present life is gone.

Looking for a subject with which to commence our investigation, we are naturally led to the beginnings and origins of existence. To the embryo fœtus in the womb, to the animalcule of the zoologist, the seed in the earth, the sporule on the waters, or the ultimate elements of matter shewn by the chemist. These, observation has told us are the depositories of power from whence all the world has been evolved. Specks or atoms themselves in their earliest rudiments, producing effects such as the animated theatre of the universe presents. Each actuated by a force of unvarying certainty, combining and disjoining with apparent destruction and formation. I say apparent; for the destruction in such cases is but a rendering latent, and the formation but a new combination. The secret virtue of the loadstone or of electro-galvanic agency may thus overcome the force of gravitation, or the power of sulphuric acid nullify that of carbonic, or vital agency generally, bid defiance to chemical affinities, or mind triumph over all. Yet all these phenomena are but in obedience to the law that the greater power gives way and becomes quiescent before the stronger. A series of *materials*, and a series of *agents*, seem to be the provision the Creator has ordained for the purposes of creation, of which we and all around us are the creatures. And amongst these, the first activities we discover commonly called vital, are the vegetative and animated forms produced in stagnant water, hatched without eggs, in contradiction to Harvey's maxim, "*omne vivum ab ovo*," at least without parent

progenitors. From these we ascend, first, to beings which spontaneously throw off others similar to themselves, as corallines, next to those who deposit eggs and seeds to be burst by their like, and finally to such as suffer gestation and bring forth young; and in no instance in the above do we find the usual order can be broken, to substantiate in the slightest the impious idea entertained by some that all might have first sprung from a shell fish or a lichen. The arrangement of *power* or *agent* is as perfect as the *material* phenomena exhibited before our eyes, and instrumental causes as manifestly *ordered* as the physical results.

From origins we next turn our attention to the earliest manifestations of form. These are found first inanimate and fixed in the mineral kingdom, wherein, ultimately the shootings of the crystal appear to imitate the plant; secondly, inanimate and growing in the vegetable kingdom, where, in its highest development, the branchings of the plant resemble the vascular system of the animals; and thirdly, animate in the animal kingdom, where mammalia resembles man himself. In the earliest manifestation of form presented in these kingdoms, we have a drop of water gathered into a ball, or a fungous growth not the twentieth size of a pin's head, teazing us to distinguish it as a vegetable, or for an animal, a round transparent vesicle discernible only by means of a microscope. In all these cases the spherical seems to be the commencing form, and a certain disposition of the material elements all that is necessary to bring the influences of life to operate. Ascending the scale we find the same order maintained. The sphere still the basis of form; the suited element the only necessary matter for its production. As water with the addition of some carbon or azote from a decomposing vegetable, alone seemed the necessary element to give birth to the infusoria and the animalcule above alluded to, so blood is the only requisite material when we treat of higher subjects. Contained in organs prepared for re-production, the various vital influences mould the blood, first into simple spheres, and thence, into all the complicated forms adapted to the life, and subsequent uses of the higher animals. Take the chick in the egg as an example of the process of such formation. The egg is a covering surrounding two substances called white and yolk, each enclosed in a membrane, and

stored up for the future development and nourishment of the chick. These are both, in all essential respects, blood. The white is pure albumen, which Dumas calls the essential part of the blood. And the yolk is a concentrated chyle or food to nourish the chick, the analysis of which also shews it in every respect to contain all the properties of blood. It is less fluid than the white, which itself, however, is not one simple fluid, but three distinct fluids, each enclosed in its membrane, each denser than the other, the densest innermost. At a certain point near the inner surface of the membrane of the yolk, the chick begins to form, folded from the first in a small sack, filled with a drop of fluid. In eight hours after incubation, nervous threads are to be discerned. On the second day, arteries and veins are discovered passing to the membrane of the yolk, together with a vessel through which the yolk is supposed to be absorbed. In the commencement of the third day, the heart is seen performing a triple pulsation from three points, and red blood freely and distinctly circulates. On the fourth day the yolk, now specifically lighter than the white, rises to the shell, and the most exquisite net work of vessels to be conceived is spread over its internal surface. In these, the blood is supposed to meet with the influences of the air permeating the shell. The yolk is now principally consumed, the white mixes with it, and the chick is rapidly forming, enlarging its own enclosing membrane till it occupies the whole shell. Lastly, what remains of the yolk and white is taken up by the vessel already mentioned into the abdomen of the chick; all is closed over by skin; and on the twenty-first day, the prison-house is broken, and the young bird escapes. What a magnificent instance within the observation of all, of the powers of life acting on suitable materials previously arranged! Here the only difference between the process described, and the gestation of viviparous animals, consists in the one being supplied with blood directly from the parent, whilst the oviparous animal has it stored up within the egg.

The blood from whence the fabric of man is formed, is a compound according to analysis, of carbon, oxygen, azote, and hydrogen; the quantity of the carbon double that of the oxygen; the oxygen similarily exceeding the azote, and the

azote the hydrogen. Besides which, blood also contains some iron and earthy salts. In its mechanical appearance when abstracted from the body, blood is very curious, separating into three parts; a solid substance of a yellowish white colour called the crassamentum or clot, a red mass which surmounts it, to which its colour is supposed to be owing, and a yellowish fluid, in which the solid mass swims, called serum. The clot is further found to be of fibrous texture, and hence called fibrine; the red part to be composed of globules; and the fluid mostly to coagulate by heat, like the white of egg. Coagulated serum is called albumen. The remainder which will not coagulate, serosity. Serosity is the gravy of cooked meat. Such is the blood of the chemist and experimentalist out of the body. In its veins and arteries how different! A bright crimson and a purple stream, leaping in the arteries, sailing through the veins, organizing at the end of the capillaries. Separate from life—a clot! Some have conceived the examination of this clot would tell them how blood organizes. How one and the same fluid forms nerve, muscle, bone, and vessel. As yet, however, it has not told them. I have given you this history to shew what blood is in death—not what it does in life. Blood is the result of digested food mixed with a portion of atmospheric air. The chyle, or digested food, when taken from the body goes through the same changes as the blood, separating into fibrine and serum. And the serum contains the same salts, but it differs in possessing an oily or fatty matter, and in wanting the red globules. This difference most likely is removed in the lungs, by the absorption of oxygen and the emission of carbon which there takes place; by which means the chyle becomes perfect blood.

Circulating through its vessels, the blood performs the most rapid movements of life, and is the origin from whence every other degree of the universal motion of the system springs. In the blood, the general impetus of life, commonly and technically called *stimulus*, originates. The heart beats on receiving its swelling current. The nerves and brain are kept in gentlest oscillations as it permeates their structure. The lungs heave their breathings to receive it, The bowels revolve in their gyrations. The muscles tingle in a joyous sense, and every secreting organ revolves from their centres

to bring forth. The arteries themselves leap on to the capillaries, and the lymphatics dilate anew. From the blood originates every motion. So also every form.

Receiving the first impetus of life, the blood *must* also receive the first and highest of geometrical forms. This must be the case since motion ever commands its peculiar form. In commencing its outpourings, each particle in all probability consists of a nest of spheres, so to express its vortex. Something like this was witnessed by Lewenhook, the greatest microscopic observer who ever lived. "The blood globule," says Lewenhook, "is a central vesicle, surrounded by two or three more, distinctly separate from the centre." In proceeding to build up the structure, and gradually losing its velocity from resisting and re-acting causes, it must next become spiral, and lastly, as a simple *sphere*, lay the foundation of primative tissue. This sphere has been seen by every physiologist who has used the microscope.

Experiments in abundance have been made to prove that the blood is a living fluid. The egg, by virtue of its life, will offer to ordinary influences extraordinary results. Kill it by means of the electric spark, and it is acted on like other dead matter. Now the egg, as I before stated, is a mass of blood. Drawn from the body, and carefully kept from all external influences, and circulated in tubes by the experimentalist, the blood changes as if it was spilt upon the ground. It dies. Shewing that in its own vessels it lived. Again, let a wound be made, and the blood pour out upon it. Shortly the blood shoots out new vessels throughout, joins them to the old, and closes the gap. Why then do we hear purely chemical and mechanical hypothesis advanced to account for the operations of a vital, nay *the vital* fluid, knowing that the laws of life place all inferior agents in abeyance. Why the clumsy supposition that the secretions are filtered, as a man would sift sand through a tube, or the vain search for every substance in the blood as it flows, which is contained in its products? Inquirers who would find the vital current filled with lime or azote, to understand whence the component parts of muscle and bone are derived, have never been, and never will be satisfied. Azote and lime may themselves be compound bodies for aught we know to the contrary. Azote or lime, as every other substance

originate where their producing causes are at work; and the producer of all things is *a spirit*—GOD!

From the intense and vital movement of the blood the warmth of the body called animal heat is generated.* The cause of animal heat has long been a disputed point with physiologists, and is still an unsettled question; for having conceived heat to be a material substance, and accordingly placed it as such under the name caloric in the list of simple elementary bodies, the chemist is troubled to shew how the blood is continually supplied with this caloric, and thus to account for all its varities of heat. I shall not detain you with the replies which have been invented to meet this question. The simpler the answer which can be given to solve any phenomena which we would comprehend the better; and when one suits us so well as the above, namely motion, I deem it unphilosophical to search for another. That the motion of the blood is the source of animal heat is proved by all its operations. The quicker the blood circulates, the more heat it evolves, as is the case during exercise, in fever, and in inflammation. The difference between the heat of the surface in winter and summer is owing to the contraction and decreased action of the vessels of the skin when exposed to the influences of surrounding cold. With increased movement the body dilates by virtue of a centrifugal force; the capacity of the vessels increase, the circulation is freer, and the warmth greater. No one can doubt who has ever rubbed two pebbles or pieces of wood, or made the most common observation, but that motion will generate heat. It will not do in these instances to say it is friction produced by contact which evolves the heat in solids, and that such a condition cannot possibly take place with fluids; for it can be proved that no actual contact of solid bodies when rubbed together ever takes place. The sphere of repulsion around all distinct objects prevents such contact from taking place. Until we can bring two stones or other bodies thus rubbed, as closely together as the component atoms which form their substance,

* Animal heat, by which I mean the manifestation of warmth in the animal body, I here treat of as *a quality* of material substance, and as such, varying with the condition of the material, and always corresponding thereto, according to certain laws regulating quality and its subject. In this passage however, (by which I simply attempt to account for the manifested heat or external warmth of a body,) I do not enter into the more *abstract* question concerning heat as it exists spiritually, in which state it seems to be the very first proceeding influence from the life itself—the cause of matter, motion, and all else besides.

we have no reason to believe we have produced actual contact. In some rare instances, (of which several are recorded in the philosophical transactions of the Royal Society,) the heat of the body has increased to such a degree that spontaneous combustion has been the consequence, and all has been reduced to a heap of ashes. These cases have invariably happened to persons who have drunk inordinately of spirituous liquors. The blood in such instances seems to be so far diluted with alcohol, that animal heat, doubtless increased by excited velocity, has set the spirit on fire; and if the drunkard escapes this death, let him beware of the highly inflammatory state into which he has brought himself. The slightest accident—a trifling bruise—or wound, is often then sufficient to cause the increased action of inflammation to spread like wild fire over a limb, mortifying as it spreads, and speedily destroying the once exquisite fabric. These are the consequences brought on the blood by indulgence in spirituous liquors.

From what I have advanced already in this and my preceding lectures concerning the blood—that in its goings forth it builds up every structure of the body, and in its returns, receives all back again, also that in itself it is ever a vortex of movement from which the vital action of every part is induced—it must be obvious, that the state of the blood is the great source of health and disease. Circulating in the condition in which it is ordained by the Creator, and in perfect and universal harmony with the life which actuates it, there is health, comfort and adaptation to use. Disease is owing to the overthrow of this harmony. This is brought about by various causes, acting from within or from without, from mental or physical sources. Instances of physical causes are such as chilling the circulation of the skin, and so stopping the action of the surface, through which the whole bulk of the blood ought to pass every three minutes. Such stoppage is a fruitful source of disease—fevers, inflammations and fluxes. Again, deluging the blood constantly with fluid, especially the alcoholic, or inducing the plethoric habit by indulgence at table, are other causes of malady. So also the slackening or retarding the action of the absorbents by a relished or gorged state of the system, or rendering the secreting and excreting organs sluggish by an inactive life. In all these cases the powers of life strive long to restore the

injured material again to health. In fever, the circulation increases to overcome and remove the external cause, and it often succeeds, terminating in sweat, some external sore or otherwise. If it fails to effect this, it lowers its movement, and from active passes to typhoid symptoms. In this last resource the patient often sinks. In inflammation the whole vital process is at first an effort to remove the exciting external cause. Suppose for instance, a foreign substance has been introduced into the body—a thorn or a nail. Inflammation is the consequence. The action of the part is increased. A fluid is thrown out to surround the foreign body, and protect the living structure. This burst outwards, and the nail or thorn is removed. Such is purely remedial or healthy inflammation, as it is called. Unhealthy inflammation is the action of a part like the limb of the drunkard, before spoken of, the destructive progress of which nothing short of the knife can stop. Between these two extremes are every shade of variety. Instances of disease of mental origin, are stagnations of the blood by means of fear, increased action from passion, &c. also many of the cases brought in by our coroners' inquests as visitations of God, where the vital action ceases suddenly without any apparent physical cause. In some of these cases life appears to be as it were internally withdrawn on a sudden, and man cut off in the midst of his career. The recent cholera presents many features of such immediate vital phenomena. Rapid failing of power and consequent dissolution of the body are here the fatal symptoms.

The first animal structure which the blood, or other universal material builds up, is a thin delicate web-like texture, called membrane. In many of the infusoria, a transluent globe composed of membrane seems to constitute the whole animal; and in man it enters as a principal ingredient into almost every part of the body. It was Haller's great work to demonstrate this; and so fully does it appear to enter into the composition of every part—covering some entirely in bag-like folds, and laying the foundations of others in cellular meshes, that it completely outlines, as it were, the human form by itself; so that membrane appears like an external tenement, into which by subsequent additions,

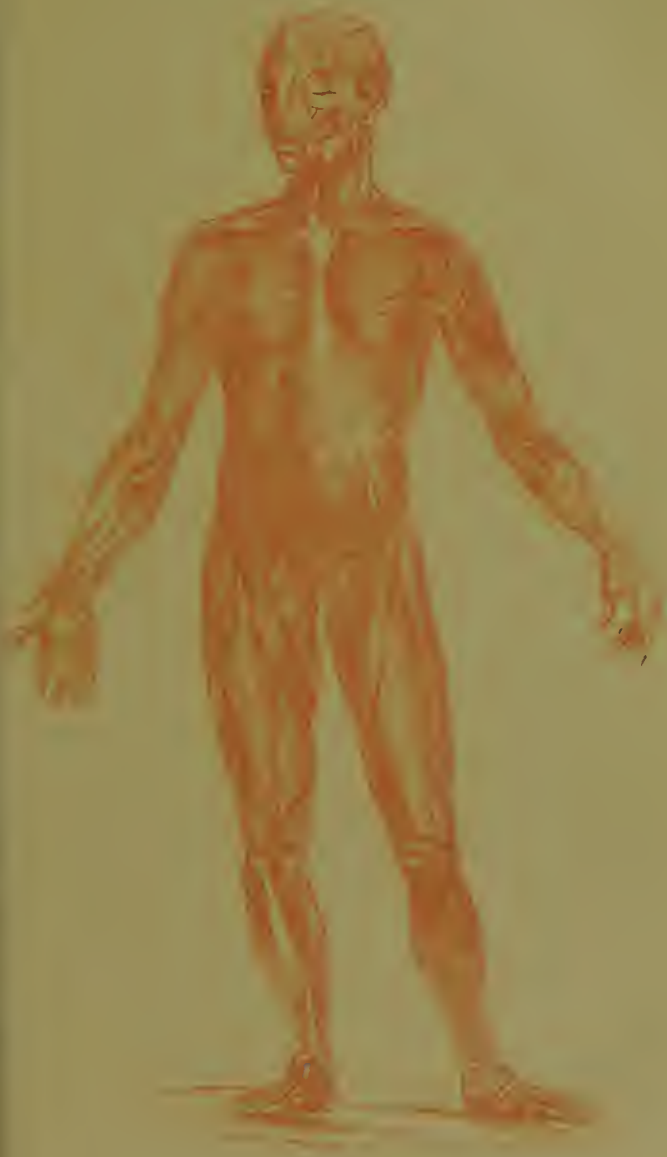
the primer and more interior parts are afterwards placed. Membrane covers the brain, and dips down into all its convolutions, sheathes the nerves, mostly composes the blood vessels, absorbents and glands, encompasses every organ in the body, and forms their parenchema or solid parts, builds up the bones, inserts itself between every muscular fibre, contains the fat in its tissues, and forms the skin. In its composition, examined by the microscope, Dr. Edwards first shewed that membrane was composed of spiral filaments, and since it has been ascertained that each filament is composed of spheres. These filaments, finer than the finest cobweb, intersect each other in all directions, leaving between them minute spaces termed areola or cells. Existing in this manner, membrane is usually called cellular tissue. It is in denser forms however, that it is usually found, when it is firm, flexible, extensible and elastic. Lining the bones and larger muscles, sheathing the tendons and joints, its fibres are very evident, and here in these situations it is called fibrous membrane. Lining the mouth, nostrils, bowels, &c. it is called mucous membrane, from being constantly moistened with a semi-fluid substance named mucus. And lining the internal organs it is called serous membrane, from being constantly bedewed by a fluid resembling the serum of the blood.

Membrane, as we might expect from its universality, is often the seat of disease, and some of its morbid affections are most complicated, some most dreadful and dangerous. Membrane sometimes distils a virulent poison instead of its soothing mucus, as in the glanders of the horse, and the catarrhal epidemic called influenza. Sometimes it knots, hardens and ulcerates, forming carbuncle on the skin, nodes on the bones, and cancer in the glands. Sometimes it pours out fluid in alarming quantities, constituting dropsy; and at others, generates air and inflates the whole body. Inflamed in the chest or abdomen, where it is extensive, delicate, and important, lining the viscera, and constituting a great part of their structure, life is threatened. Pleurisy is inflammation of the serous membrane covering the lungs. Erysipelas, or St. Anthony's fire, is also often an alarming affection. Erysipelas is inflammation of the skin; and abscess is the result of inflammation in the sub-cutaneous cellular tissue.

Combining these two affections, erysipelas and abscess, and often assuming other and new features, the skin, perhaps, of all organs of the body, presents the most numerous and complicated of diseases. Hundreds of various configurations, some of the most singular and fantastic shapes, often mar and blotch its otherwise smooth and beautiful surface. And lastly, in some instances, from the cells of the membrane parasitical animals arise. Animalcules, called hydatids in man, and flukes in sheep, form in the liver; worms in the bowels; and apterous insects in the skin. In warm climates, worms also arise from the sub-cutaneous tissue, and pierce through the skin.

Viewing these diseases, however, as well as the various uses of membrane, it must be remembered we are not considering an abstract subject, but the texture in connexion with nerve, blood vessel, and absorbent, each of which performs its part in all the above. There is not a pin's point of membrane but which contains all these. Prick the skin any where, it bleeds, it pains. The pin pierces a vessel and a nerve. The membrane must also be equally studded with absorbents, or it would form no part of the living vortex of life. Cellular membrane considered merely by itself is senseless, and in every respect perfectly passive.

Enclosed within the membrane we have the muscular and nervous tissues, which thus compose with trifling additions, the whole amount of the substance of the body. With these additions—comprising the fat in the cellular tissue under the skin, earthy matter in the bones, and secretions generally in the organs—the above tissues and their membranes, and the blood meandering through all, constitute *the whole organic man.* Muscular tissue examined by the microscope, presents the same ultimate appearance as the cellular, of an arrangement of spheres. These are placed in parallel longitudinal lines length way of the muscle, seldom or ever interwoven or crossed like membrane. Innumerable bundles of these lines, or fibres as they are termed, each enclosed in a sheath of membrane, constitute muscle. Muscular fibre enters into the composition of the blood vessels, nearly composes the entire structure of the heart, affords a coat to the stomach and bowels, and is otherwise variously distributed throughout the internal organs. Externally muscle constitutes



the flesh of the body. In a strong healthy man, muscle, in its aspect, is of a reddish brown colour, swelling, plump, and full, giving rotundity to the limbs. Its colour varies in different animals from dark brown to florid red, and in the insect class, and tribe of mollusca, is mostly white or light pink. The bundles of muscular fibre are not however all united together to constitute the flesh, but are divided into four or five hundred groups, each fastened at one or both ends to the bones, remaining loose in the centre. These attachments are called tendons. The muscle narrows to form tendon, condenses its fibre, and largely mixes with dense cellular tissue. The tendons are of a glistening white colour, affording a beautiful contrast with the loose ruddy parts of the muscle which rises from them in ample sweeping outline.

The great use of muscle is to add a series of voluntary and involuntary movements of the body in addition to the constant vital movement of the circulation already treated of. To this purpose in all its outward arrangements and forms it is adapted, as also in internal organizations. For this purpose a distinct *vitality* called muscular irritability resides in it. The organizing, plastic, central life, which resides in the blood, and seems direct from the hand of the Creator, performs its work, first laying down a foundation of senseless and passive membrane, and then, filling it, as a storehouse, with peculiar structures—the nervous and muscular fibres. These become in their turn each the subjects of a life peculiarly their own, which moreover, is also felt as *our own*, and hence obedient to our higher spiritual nature, which the life of the blood is not. It is for this end, as I observed in my first lecture—to the intent that organs of sense and organs of motion might exist the servants of mind—that the spring of life issues from the heart, assimilation supplies the vital current, and various modes adapted to its purification are kept at work. Muscular irritability, called also contractility, is a power residing in the muscle, enabling it to contract its fibres and so shorten its dimensions, and alter the situation of its parts. It is a distinct vitality belonging to the muscular fibre, found wherever the fibre is found, even in the purely vegetable kingdom, where cellular tissue most probably often

assumes the form of the muscular fibre. Cellular tissue is the foundation of vegetable as well as animal structure.

Muscular irritability constantly in all its exhibitions performs as we should expect an exquisitely adapted and arranged vitality would do. There is nothing in its action that I can perceive, to justify our terming it irritability, so admirably and wonderfully does it ever order the structure on which it operates, to ends of harmony and use. To express such a life by an adequate term I am at a loss. Contractility, in common language, merely expresses a physical effect, as elasticity, tenacity, and the like, and is, I conceive, wholly inadequate. Irritability is preferable, for this term is oftener applied to life. Muscular irritability (for I must call it so at present,) adapts the iris of the eye to the light, contracting and expanding its fibres to receive and shut out the luminous rays. Muscular irritability keeps the heart and arteries in their constant motion, and expands and contracts the dimensions of the chest, moves the food down the stomach, and causes a number of other internal operations. So also it moves every bone and joint of the body at the bidding of the will, shortening with unerring certainty the actual muscle which is requisite to effect the desired movement. It is sensitive both to internal and external demands, and ever adapts, with a most miraculous certainty, its fibre accordingly. Not only does it open and close the heart with the utmost regularity every instant to admit and expel the blood, but it will shake, heat, and palpitate every fibre to answer to a sudden mental emotion. Not only does it revolve the stomach and bowels constantly in gentlest action forwards and downwards to carry on the action of digestion, but on receiving an offending substance, a few grains of ipecacuanha for instance, it will change its whole action, and invert the order of its muscular movements, causing sickness.

It belongs to the history of this most interesting class of vital phenomena to remark, that muscular irritability does not depart from its fibre so quickly at death as the life of the blood or of the nerve; feebly lingering for a length of time, behind in gentle flutterings, especially in cold-blooded animals. The heart of the carp will contract for hours, even after it is removed from the body. All that is required to

ness this phenomenon is to apply some mechanical ulus to the muscle, that is, some external substance on ch it may re-act. All substances calling forth either scular or nervous actions, or increased circulation, are ed stimulants. Their method of effecting these results various. In the case of muscular action we know of no ater stimulant than galvanic and electric agency. If we a shock, we find it causes a most powerful spasm in the scles through which it passes; and so powerfully has anism lately been made to act upon a corpse, that all the earance of convulsive disease has been effected in the scles. Hence some have not hesitated to say that tricity and muscular irritability are the same. Let however, remember, muscular irritability is *instinct-* to effect all the complicated and wonderful movements the animal frame. Electricity, as we know it, is ely an actively attractive or repelling power, whose ere of action is the mineral kingdom; and when its uit is introduced amongst animal organization, it acts a violence blind and out of place to all intents and poses, save those of the experimentalist.

Diseased states of the muscular fibre are referable to two ls—those of the organic body, and those more immediately ifest in its specific vitality or irritability. Organically ased, the muscle may present a thin, pale, and emaciated earance, as in debility; or an inflammatory aspect. ility, or want of muscular tone, is brought on by vation, and poor, innutritious diet; also by inactivity, when muscle wastes from disuse. It is in these cases that the icines called tonics, are of so great advantage. Of ases referable to irritability of the fibre, we have three nct kinds; a want of power, constituting paralysis; ctuation of power, constituting spasm; and an increased unt of power, frequent in mania, hysteria, and the like ous affections. Numerous and sad are the varieties essed in these diseases, from complete loss of action to shaking palsy, from the most dreadful convulsive lock hydrophobic symptoms and the like, to a simple twinge olick, or a passing cramp. In some cases of mania, the ernatural strength has been such, that iron bars have snapped like twigs, and in delirium tremens attending

fractured limbs in drunken subjects, the muscle will often assume the strength of bone, so that the poor sufferer may to my knowledge, dance over the ward of the hospital, with a strength and agility baffling his pursuers, in spite of a pair of broken legs.

Nervous tissue, composing the brain, spine, and nerves, is the only elementary formation now remaining for our consideration. Like muscular tissue it consists of fibres formed of spheres. A number of these fibres, running in parallel lines and covered with cellular tissue, compose the nerves. The arrangement of the spinal cord and brain is less satisfactorily made out. In various parts of the brain, large fibres, perhaps containing a multitude of primitive ones, are distinctly visible, converging towards the base of that organ, where some most clearly cross each other, and pass to the cerebellum or posterior lobe of the brain. In the spine, the fibres are smaller, and placed in parallel lines. Thus arranged, the uses of the nervous fibre are to afford an organic seat, wherein the life of sensation may reside. Corporeal pleasure or pain, seem to reside in an exquisite sense of touch, seated at the extremities of the nerves, whence the sensation vibrates through the course of the nerve, and through all its complications. A sense of capability for making muscular actions—the muscular sense of Sir Charles Bell, which is the secret spring of all voluntary movements—seems lodged in the spinal cord; whilst animal instinct and the appreciation of sensation generally, appear to occupy the sides and basis of the brain, whither all is conveyed, and ascending the hemispheres of that crowning organ, meet with the faculty of thought and reflection. Ascending, the sensations rise—descending, wisdom and judgment stoop, in order to consider; which done, their mandate passes to the spine and is obeyed. The manner in which the nerve acts to arouse the dormant soul to sensation, thought, and action, is not agreed upon. Many an otherwise great mind has become most childish on this subject. Hypotheses the most extravagant, inventions the most gratuitous and trifling, have been offered to solve the mystery. With the materialist, the difficulty lies in making converts to his belief that ether and soul are synonymous. Could this be accomplished, then an alchymistic distillation of animal spirits would suffice. With

is opponent, ignorance of the laws which connect mind ith matter generally blindfolds. A simple and rational heory however there is in the world, to smooth even this gitation. A supposition that *harmony* is the connecting nk, and that vibrations in the nerve induce in the life rresponding volitions, which constitute all corporeal and nimal sensation. It is true, this theory involves a belief a distinct invisible creation thus made manifest. Yet this ght to be no hindrance, seeing the mass of evidence the hristian possesses to establish it. Vibrations in the fibre, though a subject surpassing ocular demonstration, I con- ive is the only satisfactory account to be given of the ysical function of the nervous tissue.

Confirmatory of the truth of this supposition, we may stance morbid as well as healthy phenomena. Pressure for stance on the brain, which must physically act to prevent ch movements, accordingly induces insensibility, whilst cing off a part with the knife has no such effect. Any nstitutional excitement, as inflammation or fever, which ds to increase universal action, hurries all the nervous sations and perceptions. Sedatives, which from their tion on the heart, we know have the power to lower action, oduces torpor and sleep, when the whole nervous system in a quiescent state. Diseases of this class, however, are t all depending on physical causes. Many are derived m the mind itself, blighted by an evil life, or disturbed by hallowed practices, whereby miserable and supernatural tes of consciousness and perception have been induced— very opposite to the beatific visions often experienced by just.

Here I must pause. I dare not allow myself this evening to ceed further. The subject towards which we are verging is *sublime*. I have already treated of the origins of animal stence, the blood, and its primitive organizations—the cel- ar, muscular, and nervous tissues; in doing which we have upied ample ground for one lecture. On this day fortnight ope to have the pleasure of again meeting you, when I pose to give a further account of each particular organ so complete our present course.

LECTURE IV.

THE HUMAN ORGANIC FRAME, COMPLETE.

INTRODUCTION—HUMAN RESPONSIBILITIES—IMPORTANCE OF PRACTICAL KNOWLEDGE—A PRACTICAL LECTURE PROPOSED—METHOD OF EXAMINING ORGANS SEPARATELY, ARTIFICIAL—THE STOMACH DESCRIBED—OUR OBLIGATIONS AS REGARDS THE STOMACH—VICE OF OVER-EATING—USE OF ANIMAL FOOD—PHYSICAL ADAPTATIONS TO ITS USE—RULES FOR DIET—ARTICLES OF DIET, ANIMAL AND VEGETABLE—THEIR CHEMICAL ANALYSIS AND ANALOGIES—FLUID DIET—WATER—ARDENT SPIRITS—CONDIMENTS—SALT—THE SAD AND FATAL CONSEQUENCES OF INDIGESTION—THE BOWELS—PROCESS OF CHYLIFICATION—LACTEALS AND MESENTERY—SUMMARY OF ASSIMILATING PROCESSES—DISEASES OF THE BOWELS—OBLIGATIONS AS REGARDS THE BOWELS—THE HEART AND LUNGS—STRUCTURE AND FUNCTION OF THE LUNGS—CHANGE IN THE AIR AND BLOOD EFFECTED BY RESPIRATION—STRUCTURE AND FUNCTION OF THE HEART—FURTHER ANATOMY OF THE CHEST—DISEASES OF THE CHEST—PULMONARY CONSUMPTION—THE CAPILLARY BLOOD VESSELS—THEIR FUNCTIONS—ORGANIZATION—THE ABSORBENTS—SECRETION—DISEASES OF THE ABSORBENT AND CAPILLARY SYSTEMS—SCROFULA—SCURVY—THE SECRETING ORGANS—OUR POWER OVER THE FUNCTIONS OF WASTE—THE LIVER—ITS STRUCTURE, FUNCTION, ETC.—THE BILE—DISEASES OF THE LIVER—THE KIDNEYS—THEIR STRUCTURE AND FUNCTION—THEIR DISEASES—THE SKIN—ITS THREE LAYERS—THEIR ANATOMY AND PHYSIOLOGY—PERSPIRATION—ITS FUNCTIONAL IMPORTANCE—RULES FOR CLEANLINESS—THE BATH—ARTICLES OF DRESS—RULES FOR EXERCISE—DISEASES OF THE SKIN—THE NERVOUS SYSTEM—THE BRAIN—ITS INTERNAL AND EXTERNAL APPEARANCES—THE SPINAL CORD—THE NERVES—NEW THEORY OF THE CHEMICAL AND MECHANICAL FUNCTIONS OF THE BRAIN—ITS EXTENSION TO ANIMALS DESTITUTE OF BRAIN—A NERVOUS FLUID—RECIPROCAL INFLUENCES BETWEEN THE NERVOUS, SANGUIFEROUS, AND OTHER SYSTEMS—SLEEP—CONCLUSION AND FAREWELL.

WE have arrived at our fourth and concluding lecture; and throughout our investigations hitherto, physiology has never failed to prove itself both a vast and sublime study. Even under our imperfect and hasty treatment, the science has shewn itself to be a mine of incalculable riches, open to all who labour for the truest and best of gain—intelligence and wisdom. The relations which we, as moral beings of thought and feeling, maintain with respect to a material organized structure, and the relations in which that structure also stands with respect to an external physical universe, are subjects which almost appear to embrace the whole

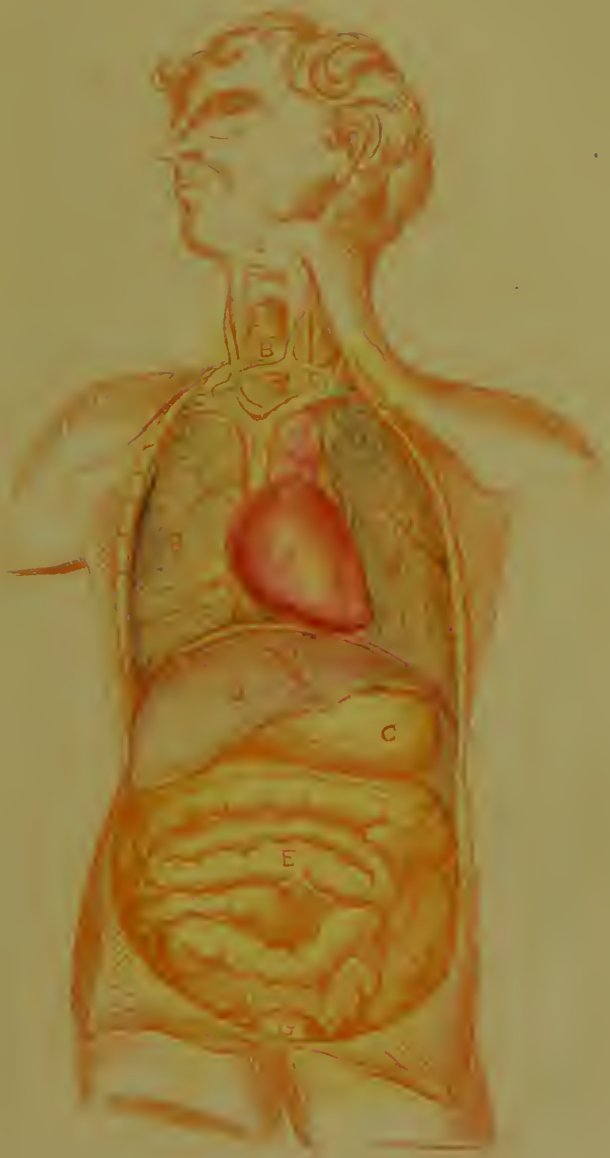
range of all legitimate science of real importance, upon those wide foundations, all that is lofty and supreme in philosophy, nltimately settles and rests; secure as a gem in its casket, or a glittering diamond set aronnd with gold and pearls. Our chief aim, throughout the three preceding lectnres, has been to direct the mind to perceive these relations, at the same time incidentally incnlcating the mighty responsibilities which they involve; peremptorily commanding us diligently to attend to their teachings, and obey to the best of our capacity; imperative only, and always, for our well-being. To practise with a knowledge of such obligations, to conform our habits according to the necessities of our nniversal physical condition, is the obvions result to which all iuformation teuds, concluding and perfecting it, and bringing its good within our possession and enjoyment. This subject, therefore, I shall make the more immediate object of our concluding discourse. Rather than incidentally, as before, I shall this evening, principally direct your attention to the consequences of *practically* working out our knowledge, by means of the physical organs which God has given us for that pnrpose—in order to become instruments of use under mental direction and control; for which sole purpose, we are, as we are, together with every ordinance of creation. Thus we shall make onr proposed examination of parts, separately and iudividually, of the utmost importance and value.

Concerning the organs comprising the humau body, however, it must be borne iu mind, that not oue of them in reality, is separate. When I say I purpose separate and individual examination, I adopt an artificial method for sake of convenience in imparting information. A separate stomach we may perhaps find in a polype; separate organs of growth may evcu extend a little higher up the scale of animals; separate nerves, and ganglions, without brain or spiue, may exist in some shell-fish and insects, but in man nothiug is separate; and in treating more particularly of one organ than another, it cannot bc too frequently or too forcibly impressed on us, that every part so particularized is a portion of the whole, and more or less under the influence of all.

The first organ I shall treat of, is the stomach, wherein commences that series of changes effected on foreign matter, which finally form it into blood, and associate it iuto the

composition of our organic body. The stomach is a bag or sac of an irregular oval form, and lies across the upper part of the abdomen principally on the left side.* It is open to the mouth by means of a tube called the œsophagus, and to the bowels by means of an orifice and valve called the pylorus. It is composed principally of cellular matter plentifully furnished with muscular fibre, and lined with a mucous membrane. It is copiously supplied with blood vessels, and its nerves are very numerous, not only ganglionic, which are the common organic nerves, but also spinal, and even cerebral. From its mucous membrane, a fluid, in all respects resembling saliva, is secreted, which is called gastric juice. Such is the organ into which our food is conveyed by the act of swallowing, which is a distinct muscular movement made by the œsophagus, by its muscular fibres, subject to the control of the will: and here, in the manner described in my first lecture, the food undergoes the first process of digestion, and is reduced to an homogeneous and uniform consistence called chyme, at the approach of which, the muscular bands forming the valvular opening into the bowels dilate, and so suffer it to pass. To aught else but chyme, however, this valve is usually impenetrable. Chyme alone will open it. If undigested food present itself, the fibre contracts firmer and closer than before; often with the tightness of spasm, causing pain. To keep this organ properly supplied with food, and so in a healthy condition to perform its wonderful functions, is an important obligation. Our system of growth and nourishment is like a tree, and the stomach like its roots, to injure which, is to cut off the means of support, and bring about its speedy destruction. To enable us in this respect to perform our duty, the vital sensations resident in the stomach are all arranged. Hunger, thirst, satiety and nausea are its guardians, and our instructors; and during the time our mental inclinations are pure and undefiled, loving the enjoyment of eating because of its use, and not longing to eat because of its enjoyment, these are amply sufficient. With the animals they are always sufficient. Not so with man. We have seen men habitually living to eat, rather than eating to live. We have seen the human faculties bent wholly on enlarging the capacities of sense, heedless of the consequences, till the world is filled

* See Plate 5. C—the Stomach. d—the Œsophagus.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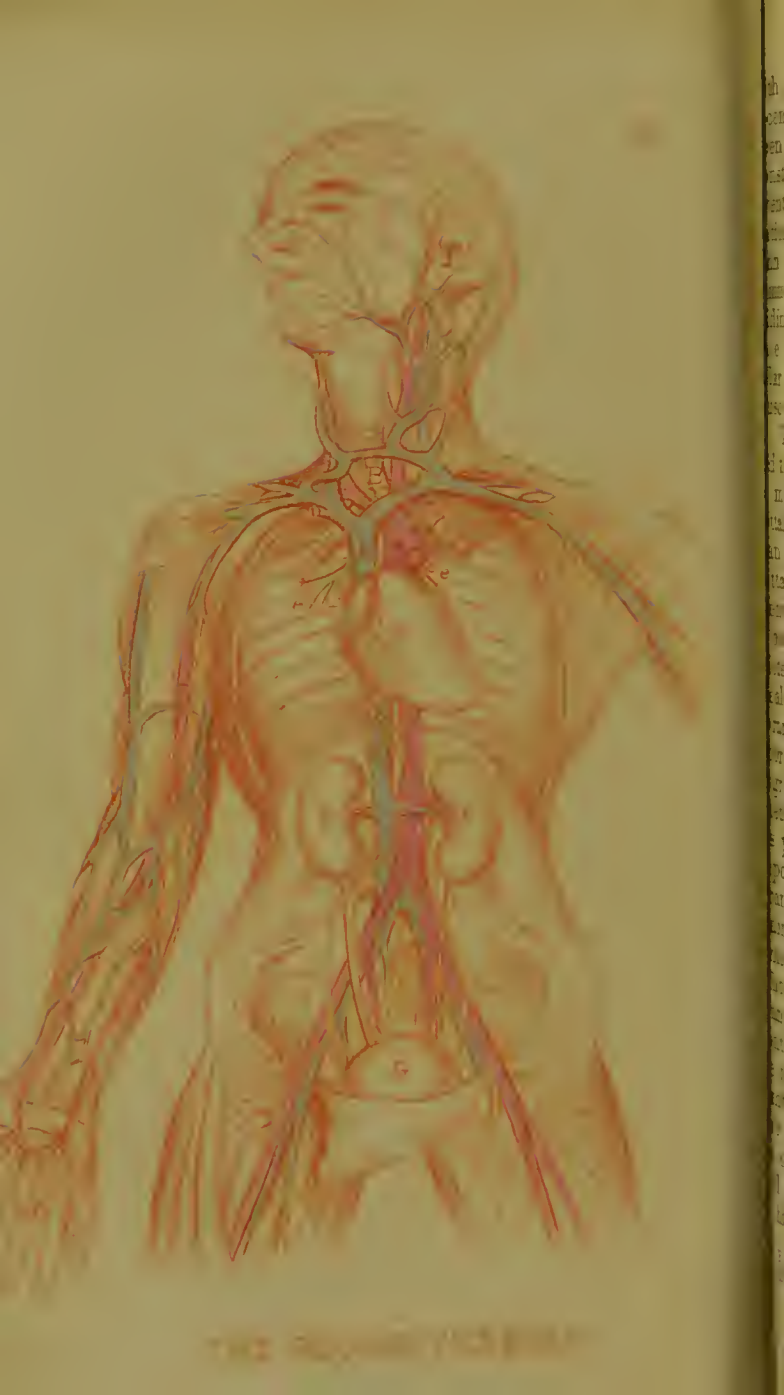

ith snares and evils, few entirely escape. Every kind of entive to provoke unhealthy appetite and false tastes have en invented, and the utmost latitude possible, is but too astantly demanded of the stomach; so that at the age of enty and upwards, the physician begins to count his ients suffering with indigestion. And a worse malady a n can scarcely bring upon himself. Indigestion, is mmon, so common, that it is often treated of as but a ling occurrence, but it is not so. Indigestion, when e fairly induced, is a constitutional disease. The mus-ar fibre of the stomach is not weakened alone. Every scular fibre throughout the body is usually weakened with The back aches, the limbs are weary, the heart palpitates, l the bowels are inactive. All this mischief, and ten times much ready to follow, is brought about for a mess of tage! Health and its facilities—the birth-right of every n at the hands of his Creator—is bartered for a mess of tage! Do any doubt the truth of my assertion? Let n look around. Let them read any of the recent works our popular physiologists: Dr. Combe on Digestion and tetics, Dr. Southwood Smith on the Philosophy of alth, Donovan's Domestic Economy, (all in our public raries, and easily obtained,) and there will they find orded the universality and enormity of a state of things graceful in the extreme to our social world. Baglivi, a brated Italian physician, mentions that a large portion of patients recover during lent, when religious observances pose restraint on their appetites. Professor Caldwell, of nsylvania University, Kentucky, inveighing severely inst his countrymen, tells them, that one American con-nes as much food as two Highlanders, or two Swiss, nough the latter are amongst the stoutest of our race. Sir ncis Head, describing German feeding in a work on ntinental Watering Places, expresses his astonishment at provision invalids and sojourners there so placidly con-nc.* In short, there is scarcely a physician to be found, is not forced to admit, that most persons indulge in the of a greater quantity of food than is conducive to health. l the man who believes that he must faint if he loses one his five or six meals per diem, that Charles the Tenth, of

* For these examples I am indebted to Dr. Andrew Combe's work on Digestion Dietetics.

Sweden, actually passed five days without a meal, and then rode two leagues, and dined without inconvenience; and let him know if his situation is so desperate on the loss of a meal, that his debility is of his own providing, and that man really needs but some ten or twelve ounces of bread and water in the twenty-four hours, to carry him on, strong and vigorous, towards a century of years.*

There is an opinion popular in the world that such a mode of dieting is incompatible with the development of muscle, and the sustaining of strength; for which purpose it is stated that animal food is absolutely requisite; and it appears from the testimony of those who leave off its use, that with our social habits, animal food eaten in moderate quantities is a *necessary* article of our diet. But from this circumstance alone we must not hastily form a general opinion. Who thrive so well as young children, who never taste a piece of meat? Meat to a child, before he can well masticate it, is decidely injurious. Worms and eruptive diseases are the common consequences. The poorer orders of peasantry of Ireland are almost strangers to animal food. They live chiefly on potatoes. Yet whose frame more athletic, countenance ruddier, longevity greater, than that of the Irish peasant? And I may add, in spite of national prejudice, with Dr. Donovan, who cites this example, whose intelligence greater than the Irish peasantry? The Scotch also, compared with the English, eat but little meat; and in France, at the present day, less cattle are killed than before the revolution, though the population is nearly double. The Negro's agility, vieing with the horse in a race, is well known, and the South Sea Islander can rival our stoutest seamen, yet neither people are meat eaters, and both are nearly exempt from disease. And there is every reason to believe, that famous Grecian and Roman republics in their most glorious era, fed mostly on bread, vegetables and fruit. In tropical climates, the Bramins in India, and the people of the Canary Islands, Brazils, &c. live almost entirely on grain, herbage and roots; whilst the miserable timid inhabitants of Northern

* This was the regimen of diet observed by the early Christians, as mentioned in Donovan's Domestic Economy, referred to in the First Lecture. The diet of the working people of England and Scotland in general, is about 24ozs. of solids per day, chiefly meal, and only a small part animal food. Vide Chambers' Edinburgh Journal, vol. ix. p. 268.

Europe, as remarkable for their moral as physical debility, ve chiefly on fish and raw flesh.*

Sometimes it is asserted that comparative anatomy and hysiology point out that man is intended by nature to eat eat. Structural indications of such design, however, are far om forcible, and no greater than we may conceive would ave taken place if not originally present, to adapt the body the present habits of the human race. Gassendus, with any other celebrated men, believed that it was not originally tural for man to feed on flesh, and that it was not until after e flood that he did so. And this opinion, structure favours more than a contrary one. Our teeth are chiefly incisors cutting teeth, molars or grinding, and of such as in rnivorous animals are calculated to tear flesh, we have but r called canine, from which Gassendus concluded that ture had constructed our teeth for cutting roots and herbs, d for grinding grain, nuts, and hard fruits, but not for ring flesh. When we do feed on flesh it must undergo a evious process of cookery, and even in this state, we refuse to those labouring under various diseases.†

To teach us how to enjoy health, and duly respect the mach, has occasioned, many a volume to be written on the ject, tables of digestible and indigestible food to be wn up, hours to be appointed as best for taking meals, l quantity best to be eaten, with a hundred other minutiæ. tter, however, than all these, are frugal habits, abstemious ing, and mastery over one's own appetites, diligently using the same time all our common observation, and profiting ordingly. Trifling errors, with such habits, would pass eeded by. The stomach, active and vigorous, will digest mall portion of all ordinary substances, and perform its ctions in that quiet harmony, which every dyspeptic so nly remembers to have been one of the peculiar delights is childhood.

Animal products usually employed for the purposes of l, are the flesh of mammalia, birds, and fish, with several the crustaceæ and testaceæ, milk, cheese, butter, and s. The flesh of mammalia chiefly consists of fibrine, e solid portion of the blood when removed from the y,) together with a quantity of jelly. Fish contains

* Donovan's Domestic Economy, vol. 2, p. 299, 302. † Ibid, p. 289.

more albumen, (the coagulable part of the serum,) together with gelatinous matter. Milk may be considered as an emulsion of albumen, oil and sugar. Butter and cheese as the same, the water being removed. Eggs are chiefly albumen.

Vegetable products commonly used as articles of diet, are fruits, seeds, roots, stalks and leaves, in which chemical analysis detects a series of principles analogous to those forming the animal substances, and as readily converted by the process of healthy digestion into blood. These are gluten, farina, and mucilage, oil and sugar. Gluten is a fibrous tenacious form of matter, containing all the elements of the animal fibrine: that is oxygen, hydrogen, carbon and azote. It abounds in many seeds, as in wheat, and forms as concentrated an article of food in bread, as meat itself. Farina or starch is plentiful also in seeds, and often in roots, as the potatoe. Gum and sugar are composed of the same elements as starch, differing only in their proportions, and may be considered on a par with fish and eggs in point of nourishment. Oil and sugar are products in common with both animal and vegetable. Oil abounds in fish, sugar is plentiful in milk.

Of fluids used in diet, water is the principal, and the basis of all others. Our drinks are either simply water, vegetable and animal decoctions, or fermented liquors. Infusions of coffee and tea are our most usual beverages; and these saving their watery menstruum, are rather grateful than directly nutritive. In fact, they are pleasant ways of drinking warm water, proved by experience to be harmless, unless taken in excess. Very different, however, must be our account of fermented liquors. Of these, a little ought always to go a long way. Sparingly used, they may occasionally form a variety of our diet, but always with caution. This indulgence, however, I would by no means extend to ardent spirits. As medical agents, distilled spirits may be occasionally valuable, but as articles of diet, they are always more or less pernicious.

Condiments and salt complete our list of food; the former of these are used by most nations, the latter by animals as well as man. Dr. Bostock ingeniously suggests that spices

may be providentially ordered to prevent acetous fermentation in the stomach, where fruits and vegetables form the chief article of diet; and salts and acids may serve to prevent animal matter from degenerating into the putrid state. Beasts of prey in central Africa and America, will travel immense tracts for the purpose of visiting the salt springs that are occasionally met with, and it is said, that these springs have been in some instances discovered by means of their footsteps, and by the hovering of birds over them.

In healthy digestion—attending a careful and proper use of the above ample table of nourishment, which surrounds man on all sides, in every quarter of the habitable globe—the substances he takes into the stomach, in a few hours pass thence through the pylorus, in a pultaceous and almost fluid mass of a greyish colour; and thus we are led to the consideration of the bowels, and their functions. But unhealthy digestion, that is indigestion, detains us yet a few moments longer with the stomach. Distended to the uttermost by an improper quantity of food, hastily swallowed, and half masticated—for deficient mastication always attends disordinate eating—the muscular fibre of the stomach is prevented from making its healthy movements, by means of which, the food is properly mixed with the gastric juice. Digestion is prevented going on. The fibre is weakened by the continual stretch and tension put upon it; till in the end, even to the smallest quantity of food, it refuses to act. The food is detained longer than it ought. Bile enters the stomach from the bowels through the pylorus, now no longer on guard, but mechanically dilated; and indigested food escapes into the intestines. Sickness, diarrhœa, and pain, follow the unnatural irritations that are now going on, perhaps inflammation. After a time, however, if the food has escapes into the bowels, there it remains. The bowels no longer respond to its stimulus, they are debilitated as well as every other portion of the body from being insufficiently nourished, for the mischief in the stomach has cut off the necessary supplies. Now the bile is absorbed into the blood for it cannot pass through the intestines. Jaundice follows. Vertigo, hypochondria and melancholy, perhaps suicido succeed. If not, speedy emaciation—ultimately decline.

Such is a case of indigestion; and man loses his life rather than a morsel of food; aye, and no physician can save him. His life and death are in his own hands.

The intestinal canal or bowels is a long winding cylindrical tube about six times the length of the whole stature of the body, in structure similar to the stomach.* Here in its commencement, next the stomach, the food undergoes a further change. From chyme it next becomes a substance nearly resembling milk or rather cream in appearance, called chyle. This is rapidly absorbed, as it moves onwards with the peristaltic action of the bowels, by a set of vessels called lacteals, and by them is conveyed into the veins and mixed with the blood. The lacteals effect this, by finally joining into one vessel about the size of a quill, termed the thoracic duct, which passes up by the spine, and enters the less subclavian vein not far from the heart. Covering the bowels, the lacteals are imbedded in a cellular tissue called the mesentery, a portion of which is beautifully represented by a wood cut in the popular Treatise on Physiology published in the Library of Useful Knowledge—an invaluable book of its kind, costing but eighteen-pence.†

Mastication, chymification, commonly called digestion, and lastly chylification performed in the bowels, involve both mechanical, chemical, and vital actions, in their operations. In the mouth, diluted with the saliva, and comminuted by the teeth, the action on the food seems to be mostly if not entirely mechanical. In the stomach, the gastric juice changes the order of the elements chemically, and reduces all to an homogeneous consistence. Here the mechanical action of the muscular fibre merely mixes the food and urges it onwards towards the bowels. In the bowels, the food assuming the form of the blood, in addition to mechanical and chemical, receives vital influences, and the chyle as it is emanated from the mass, becomes a habitation of life similar to the blood itself. The mechanical action of the bowels urges forward their contents. The chemical action which goes on in them, is effected by the presence of two fresh fluids now added: the bile and the pancreatic juice, which flow from the liver and the pancreas directly

* See Plate 5, letter E.

† For a representation of the lacteals and thoracic duct, see the plate of the absorbents, Lect. 2, p. 55. (The course of the thoracic duct in this plate, is marked out in *front* of the viscera, in order to be shewn.)

into the chyme as it enters from the stomach. Of these fluids the pancreatic resembles in appearance the gastric juice and the saliva, which are similar. The pancreas is like a salivary gland joining on to the intestines. Bile is a bitter, viscid, greenish yellow fluid, mostly composed of resin, soda, and albumen, dissolved in water, hence containing a great quantity of carbon, of which resin principally consists. The action of these fluids is not determined, but I think there can be little doubt but the pancreatic effects the formation of chyle; and the bile, the removal of the residual dross which is finally carried from the system: and in this opinion I am further strengthened by the analogies existing between the liver and the lungs as excreting organs, which I shall presently notice when speaking of the secretions.

The influence of our conduct over these vitally important actions going on in the bowels, is our next consideration. This is greater than at first may appear, and yet scarcely so, when we remember how far health or disease is in our own hands; and that in health alone we can enjoy the proper and undisturbed action of any organ whether bowels or otherwise. As to the necessity of keeping the stomach in proper order, I need not say more than I have already advanced; our further influence on the bowels principally depends on the activity of our occupations, and our mental or nervous condition. Active modes of life, a well regulated and contented disposition, and abstemious habits, together with proper and sufficient clothing for the skin, and the breathing of pure air, will, (accidents apart,) insure to us all we need from the bowels. Under such regulations their peristaltic motion is vigorous and uninterrupted, their secretions free and easy, neither superabundant nor scanty, and their tranquillity, ease and comfort, certain and constant. Anxiety or fear, or habitual melancholy, listlessness, or indulgence in false excitement, with various other mental affections, will derange the bowels, now causing diarrhœa, now constipation. Inactivity and idleness mostly constipates. Checked perspiration induces relaxation; and breathing impure air diseases the liver; so also heated or stagnant air, by which the cholera of warm climates is mostly caused.

Disturbed by mental influences, a trembling sensation is felt in the canal, most probably occasioned by nervous vibrations. Blood accumulates in the capillaries of its

membranes, as in the act of blushing it suffuses the capillaries of the skin. The mucous secretions of its internal surface are augmented in quantity, and diarrhœa sets up its action. The immediate cause of constipation from inactive habits, is the unnatural and improper quiet and torpor in which all the surrounding muscles are in such cases always kept. The contraction and movements of the muscles which form the sides of the body, bring a sphere of activity and animation in contact with the bowels, and increases the movement of the blood throughout their vessels. Indirect sources of mischief, caused by idle habits, are to be traced to their general debilitating effects on the whole system, inducing a universal dyspeptic and chlorotic diathesis. Checked perspiration causes relaxation by detaining a mass of heated blood in the system, and injuring other organs as well as the bowels. A diseased liver affects the bowels from the unhealthy secretions of bile which it pours into them.

We have now stretched to the utmost limit we can allow for the organs of digestion. We have followed the food as chyle into the veins, and find the heart and lungs demanding it. These organs therefore are our next consideration. The heart and lungs occupy the whole of the chest, separated by the midriff or diaphragm from the abdomen.* In the centre is the heart, from whence in every direction are spread around a forest of vessels, branching off into the minutest capillary twigs, finer than the finest hair. Half, arteries, springing from the right side of the heart; half, veins, communicating with the left. These are the blood vessels of the lungs. They are connected together with the most delicate tissue, and ultimately arranged around myriads of small cells, only to be discerned by the microscope. Each of these cells opens into a vessel of its own, ramifying upwards towards the wind pipe, and is filled with air. Thus air vessels and cells proceeding from the wind pipe, connected with capillaries and blood vessels proceeding from the heart, all firmly connected together by tissue, form the wonderful structure of the lungs.

* See plate 5 and 6; A, the heart; *a*, the commencement of the arterial system, (the aorta;) *b*, *b*, the termination of the venous system both from upper and lower parts of the body, (the vena cava, inferior and superior;) *B*, *B*, *B*, the trachea or wind pipe and the lungs, (the lungs are removed in plate 6;) *c*, *c*, plate 6, the commencement of the pulmonary vessels; *f*, *f*, plate 5, the diaphragm.

The chief function of this highly important organ is to add air to the blood. This is effected in the above mentioned cells, into which fresh air is introduced at every inspiration; the delicate membrane of the capillary blood vessels forming no obstruction, containing the blood without shutting out the air, which accordingly permeates its structure. Besides this function, the lungs are also excreting organs, expelling with every expiration a volume of deleterious gas evolved from the capillaries, both immediately previous to and after each inspiration. The air received into the blood however is not the whole atmospheric air which is breathed, but only a constituent part called oxygen, the remainder called nitrogen being expelled at every breath with the deleterious portion above named, which is called carbonic acid, or carbon united to oxygen. The nitrogen of the air is sometimes found to enter the blood with the oxygen, especially in winter; whilst in summer on the contrary, the lungs often give it off from the blood, of which it is always a constituent part.

Some physiologists have supposed that oxygen is not absorbed as I have stated, but that all the oxygen consumed during respiration, is converted into carbonic acid in the lungs, by the addition of carbon evolved from the blood, and then expired. But this supposition is now disproved in two ways; first, there is usually more oxygen lost in respiration than would make up the amount of carbonic acid afterwards expired, and secondly, animals deprived of all oxygen have been found to expire carbonic acid. Dr. Edwards, to whom we are indebted for the most accurate experiments on the subject of respiration, confined frogs in pure hydrogen, in which they are capable of existing for a length of time, and carbonic acid was evolved from their lungs. The same result he obtained from fishes and young kittens, (for many of the mammalia will live for a short time after birth without oxygen.) In all carbonic acid was evolved from the lungs.

Purified from carbonic acid, and replenished with oxygen, the blood from a purple becomes bright crimson, and so returns to the heart, whence it sets out dark and purple. How long this crimson appearance is maintained, is not known, perhaps it is only in the lungs. The common received opinion is that the whole arterial system is crimson,

but this probably is not correct. Hunter observed, in taking off a limb, that the blood direct from the artery was purple, which instantly becomes red on exposure to the air. Crimson blood, hermetrically sealed in glass, soon becomes purple, shewing that the presence of oxygen alone will not preserve this colour. Cold-blooded animals, it is well known, have no crimson blood.

The function of the heart is to receive the blood from the veins, propel it through the lungs, take it back again, and again transmit it to the system. The heart is a strong hollow muscle of an irregular conical form, lined within and without by membrane. Its interior is divided into two cavities called ventricles, each of which communicates with a semi-membraneous, semi-muscular bag, called an auricle, attached to its outside. Into one of these auricles the great veins of the body enter, and pour the blood. The auricle, when filled, shuts out the veins by a valve, and contracting, forces the blood through an opposite valve into the ventricle, it then dilates again, in doing which, the valve looking into the ventricle is in its turn closed, and the vein again opened. Thus venous blood is constantly propelled into the left ventricle, which instantly contracts on receiving it, and pours the whole through the vessels of the lungs, dilating again when it has discharged it, to receive a fresh supply. From the lungs the blood flows into the second auricle, which receives and transmits it into the right ventricle, by a similar process to that already described, and from thence it is forced into the great arterial system.

This grand apparatus, consisting of heart and lungs, in which the blood is perfected and formed, and receives its first mechanical impulse, is the prime essential of the organic structure of every other part. Accordingly, it occupies the centre of the human frame, entirely filling the chest, and is especially protected with investing membraues, and the ribs, by which it is surrounded. Its nerves are chiefly the great sympathetic or ganglionic, (called also intercostal, from their prevalence in the chest,) whose function appears to be to connect all the parts in healthy and agreeable sensation, and assist in producing the organic operations. Besides these, the heart and bronchia are also supplied by the pneumogastric from the brain; and the ribs and diaphraghm by the

intercostals of the spine, by the former of which, the chest and abdomen are both directly associated with the brain, and by the latter, the muscles of respiration are put in some measure under our control. The ordinary vital actions of the chest, however, are independent, and solely owing to muscular irritability, unconnected with the voluntary nerves, both as regards the motion of the heart, and the alternate raising and depressing of the ribs and diaphragm in respiration.

The importance of these organs as concerns organic life, makes their diseases particularly distressing and fatal. These diseases, as far as regard the lungs, are frequent amongst us; owing partly to climate, and partly, and principally, to certain injurious habits common to our social intercourse. The heart, generally, is more exempt from suffering. The most fatal, almost, of all diseases, is pulmonary consumption, towards which, perhaps, one half of our population is more or less predisposed, the mischief shewing itself on the first exposure to an exciting cause. Predisposition to consumption, and tuberculous diseases generally, seems to depend on a peculiar organic structure, and is mostly hereditarily derived. This predisposition is in the first instance, doubtless, induced by imprudent and intemperate habits, and non-attention to those which are natural and healthy, especially as regards the constant breathing of pure and unconfined air. On constitutions thus shattered, and on their offspring, the climate next acts as an exciting cause. But climate is not the principal and incipient source of the mischief, for in mountainous districts, and on the sea coasts, where the inhabitants are most exposed to its changes, consumption is rare. It is in our luxurious cities, and thickly inhabited towns, midland the kingdom, where the disease is most prevalent. Pulmonary consumption is a complete breaking up and disorganization of the structure of the lungs, and is, when it has proceeded far, incurable. At first, a morbid secretion is infiltrated into the cellular tissue of the lungs in minute quantities, and in various parts, constituting what are professionally called tubercles. This is undoubtedly the result of an unhealthy state of the membrane. Next, inflammation sets up around these morbid secretions, which cause irritation, as a thorn or other foreign body, if present, would do. The inflammation goes on to

suppuration. Pus is formed, and an ulcer produced. Imagine a series of ulcers on the delicate structure I have already described; in some places, one running into another, and so forming large excavations, and you have a picture of the lungs in consumption. In this stage of the disease, hope, so often present, may indeed be said to tell a flattering tale.

It is commonly supposed, that largely partaking of animal food is a protection to the consumptive patient, and the pretty general exemption from this disease, which butchers certainly enjoy, has been attributed to their eating largely of their trading commodity. If eating meat, however, would save us from consumption, then beef-eating England, instead of the principal, ought to be the last nation in the world to suffer. I should rather attribute the health of the butcher, to his active habits, and out-door employment, than to the imagined protection, which is as commonly partaken by thousands who suffer from this disease, as by the butchers themselves.

Briefly to mention a few other prevalent diseases of the lungs. Increased secretion, often attended with slight inflammation of the mucous membrane of the large bronchial vessels, constitute the coughs we are all so subject to. This affection like diarrhœa in the bowels follows checked perspiration, damp feet, or cold otherwise suddenly brought to the surface. Such increased secretion in old persons usually continues for a length of time, and often returns with every winter subsequent to its commencement. Active inflammation may attack any portion of the lungs. In these cases it is mostly the plethoric who suffer. Asthma is a spasm in the muscular fibre of the air vessels. It is mostly complicated with some other bronchial affections, and often a purely nervous disease, that is, the spasm follows from nervous excitement. Of the diseases of the heart, enlargement and partial ossifications are the most common. In cases of enlargement, if one ventricle alone is hypertrophed or enlarged, the other often becomes atrophed or diminished. Suffocation of the lung with blood, follows such partial enlargement of the right ventricle; apoplexy of the brain, enlargement of the left. Talma, the great French tragedian, died of enlargement of the heart. This disease is usually connected with a highly nervous and excitable mental

condition. Ossifications are most common to aged persons. They are often complicated with rheumatic affections of the heart, and a very severe and painful state of the organ, obscurely known under the name of angina. Sometimes, tumours form in the large vessels about the heart, which bursting, instantly destroy life. These are called aneurisms.

After these few remarks on the centre of the sanguiferous system, where the blood, as it were, originates, we next proceed briefly to consider the course and destiny of the vital fluid—its functions in organizing the general structure. This structure is, as you will remember, a series of globules, arranged into tissues, compacted and united together into solid strata, containing in certain parts other substances, such as are usually called inorganic, as earthy matter in the bones, fat and jelly, mucus, oil and water, &c.

The commencement of the organic process is in forming vessels, and is beautifully shewn in the closing of an incised wound or cut, the blood from which may be seen, shooting out into vessels, joining on to either sides of the wound. These vessels, from their extreme minuteness, are called capillaries. They are supposed to exist in every portion of the living structure—in every primative tissue, each globule of which, I conceive, may be a series of capillaries connected on to the next globule, and so maintaining the entire organization in one perfect whole, depending on the circulation of the blood. Thus the heart and great vessels are formed that the capillaries may exist, and thence the whole. The inorganic depositions above alluded to, are in all probability transpired through the sides of the vessels.

The completion of the organic process, thus reviewed, and the formation of man, as he exists, is a perpetual work. Waste and replenishment are continually going on; absorption, secretion and excretion, never cease their operations; so that the blood in the capillaries must ever be depositing its fresh organic particles to maintain its vessels entire. The absorbing system (already described in the first and second lectures,) is a vascular apparatus, constantly removing, by a suction-like power, every old particle from its place in the body, and returning it again to the blood whence

it was deposited. Secretion is the separation of such particles again from the circulation, that they may be finally excreted as worthless. Secretion is a term signifying separation, and hence is generally in use, not only for this class of operations, but also for the above-mentioned inorganic formations, transfused through the vessels as necessary parts of the system; as mucus, fat, synovia, &c. This indiscriminate use of the term, however, in my opinion, is highly objectionable, confounding in speech two separate functions, and causing unavoidable confusion in idea.

Disease in the absorbent and capillary systems constitute what may be termed general or universal maladies in contradistinction to local. In every disease, of course, the minute vessels and structure suffer, but there are states of suffering most peculiarly capillary and universal, to which I now allude. Such are atrophy, or emaciation; scrofula, or evil; and scurvy. In all these, the absorbents seem to be dangerously active, and the structure either entirely shrinks and wastes, or is broken up by ulcerations. The blood vessels also, especially in the two latter instances, appear to be morbidly affected.

The secreting organs are principally the skin, the lungs, the liver, and the kidneys; each separating and removing from the system, peculiar substances; the lungs, carbonic acid; the skin, a watery fluid, called perspiration; and the liver, bile. Each of which are highly important functions, and so essential, that the prevention or disturbance of their constant action, is incompatible with health, nay, with life itself. Nitrogen and carbon are the principal elements thus removed, each of which appears more essential to the solid structure, than to the blood, judging from the quantity of the latter element contained in the muscular fibre, and of the former evolved continually from the lungs. Like as we have power over replenishing our bodies with sustenance, so in a certain degree, we have power over these functions of waste, especially as regards the skin. Cleanliness and activity are the great secrets of health as far as regards these subjects. Active habits will insure healthy respiration, and proper secretions of bile; cleanly practices, the comfort and normal action of the skin.

The structure of the lungs I have already described. The structure of the liver, kidneys and skin, yet remain to be noticed, to complete our subject.

The liver, in its general description, is a large glandular organ, occupying the whole right hypochondria, situate directly beneath the diaphragm, and above the stomach and bowels * It is of a dark red colour, and when divided, looks as if it were composed of a number of minute grains. Its blood vessels are principally veins from the spleen and mesentery, which enter it united, and secrete the bile. Besides which, arteries and veins, direct from the general circulation, also ramify throughout for its nourishment and support. Its nerves are the usual organic nerves; a plexus derived from the sympathetic. The gall bladder is a pear-shaped bag, joining to its under surface, to receive the bile as it is secreted, and discharge it, when it accumulates, into the intestines. Minutely examined, every grain of which this large organ is composed, is itself a little liver, perfect in all its parts, principally formed by the capillaries of the splenetic and mesenteric veins, whence the bile is secreted. Each of these grains, or lobules as they are called, is distinct, and furnished with its nourishing vessels and secreting tubes, which carry away the bile to the gall bladder, near which, the tubes all unite from their million sources into one.

The bile, in all probability, is wholly an excrementitious formation, removing from the blood certain resinous and inflammable matters, previously deposited by the absorbents. This opinion is strengthened by the analogies the liver bears to other excreting organs, particularly the lungs. Any cause tending to prevent the escape of the carbonaceous matter from the lungs, increases the action of the liver. So also, when fat is either absorbed, or its deposition prevented, the liver increases its secretions; and in short, whatever tends to accumulate inflammable matter in the blood, increases the action of the liver. In constipation, the secretion of the liver is usually very scanty. In diarrhœa, cholera, and other similar relaxations, it is profuse. Like the lungs, the liver is subject to tubercles, and extensive ulcerations, commonly terminating fatally. These cases are vulgarly called liver complaints.

* See plate 5, letter D.

The minute organization of the kidneys is similar to that of the liver, the grand whole being but a compound of innumerable smaller parts, each itself a perfect kidney. Here the lobules are all situate around the external surface of the organ, and from each a long tube carrying the secreted fluid ramifies towards a grand central reservoir, whence one large vessel leads to the bladder.* These two parts, composed of lobules and vessels, are called cortical and tubular. Contrary to the liver and the lungs, the kidneys secrete from the arteries, whilst bile and carbonic acid, in the two former organs, are given off from the veins; hence the lobules of the kidneys are less complicated than those of the liver, consisting merely of convoluted vessels, from which the blood most probably oozes out its watery secretion as it circulates; whilst in the liver, the whole portal system, that is, the splenetic and mesenteric veins are entirely for the purpose of pouring out the bile, requiring arteries and veins from other sources for the nourishment and support of the organ. The nerves of the kidneys are a plexus of the sympathetic. The secretion of the kidneys is the principal exit for nitrogen or azote from the system. This is the same in all animals, whether carnivorous or simply graminivorous; with regard to the latter of which, it is a puzzling question to ask the chemist, whence is the nitrogen derived, not only in the quantities here present, but also in the muscular fibre? This secretion, like the bile, alternates in its amount, according to the activity of the other organs of waste, and in one particular state of the constitution called diabetes, it is formed with destructive rapidity. When it deposits solid substances in its course, it causes the disease called gravel and stone.

The skin is a compound structure, made up of three layers. The true skin, called cutis vera or corium; a mucous layer, described by some as tissue, and called rete mucosum; and the scarf skin or cuticle. The corium is the innermost of these, and may be regarded as a dense tissue of blood vessels and nerves. It rests upon cellular membrane and fat, which separate it from the muscle. Its external surface, under the microscope, is seen to be filled with elevations, called papillæ, which are supposed to be the ends of the nerves, and the seat of the sense of touch; besides which, also it is

* See plate 6. FF—the Kidneys. G—the Bladder.

filled with small pits, from which an oily fluid exudes, these are called sebaceous glands or follicles, and their use is to lubricate the skin, and keep it pliable and soft. It is from the centre of similar depressions, that the hair arises. The nails also are firmly fixed in the corium.

The corpus mucosum, called also rete mucosum, or mucous net work, appears rather a semi-fluid deposit or secretion, than a cellular tissue. It lies between the corium and the cuticle, and is the seat of the colour of the skin, the cuticle covering it being transparent. It is very various in thickness in different complexions; thickest in the negro and man of colour, in whom the corium is as pale as in the European. It is so thin in many Europeans, that its existence in the white has been denied by some anatomists, and the Albinos, most probably, are destitute of it. The corpus mucosum is the seat of colour also in the skin of animals, as shewn by the cocks' comb, and the brilliant colour of fishes. Neither nerves nor vessels have been discovered in this layer.

External to both these layers, we have the cuticle or scarf skin, a thin delicate surface in most parts of the body, smooth beneath, but on the surface filled with creases or marks, which on minute inspection, give it the appearance somewhat of scales. Concerning the organization of this surface, anatomists are undecided; but its ready production in cases of injury, and its capability of evolving the cutaneous perspiration, and yet to resist the escape of any fluids settled under it, as in the case of blisters, forbid our considering it as a mere crust or film, the result of cutaneous exudation, as some have supposed it. It is destitute, however, of sensation, and becomes, as it were, a guard and protection to the papillæ of the corium, modifying the exquisiteness of their sensations. No pores to allow of the transpiration of perspiration have been discovered in it. This, however, is not surprising, for it is so elastic that it will not even shew a pin-prick when the pin is removed. Pressure increases the thickness of the cuticle, apparently the better to enable it to protect the true skin. Thus the handling of bodies has made it thicker on the hands than elsewhere, excepting on the soles of the feet. Pressure, however, to effect this change, must be gradual; if violent, or attended with much friction, it raises blisters, and so separates it from the body. Corns on the

toes are thickened cuticle produeed by pressnre. Their absorption, I believe, is best produced by friction, hence their best treatment is the corn rubber.

As a secreting organ, the skin perspires. Perspiration is almost entirely an aqneons secretion, and usually escapes from the body in the form of an invisible vaponr, which, however, is readily apparent at all times, if allowed to condense on a eool mirror, brought near for that purpose. If inereased by exciting the activity of the skin beyond its usual action, the perspiration then gathers in drops on the surface, and is called sweat.

To maintain this function of the skin in its healthy condition by careful conduct on our parts, is one of the most essential and requisite duties which devolves npon us. For this purpose, active habits, warm and sufficient clothing, and particularly, cleanliness with respect to the skin itself, are the principal requisites. Persons generally, are not aware of the full extent of the latter of these duties. It is but too commonly supposed, that daily ablution of the face and hands is sufficient washing. Those, however, who know the nature of the animal secretions, eonstantly going off from the skin, and have experienced the nsefulness of the bath, or sponging the surface daily and entirely, which is in the power of every individual to praetise, bear testimony to the fallacy of such an opinion. The salts of the perspiration, and the secretions of the sebaceous glands, whieh are constantly deposited upon the skin, if not often removed, in time irritate, producing eruptive diseases and ehecking perspiration. The amount of these accumulations in the day is surprising, as any one may witness who rubs himself with a flesh brush, or the horse-hair gloves lately invented, as frictors for the skin. These are speedily covered by such rubbing with a kind of scurf, which is accordingly removed from the cuticle, and may be dusted out of the frictor, like flour or powder. The addition of a spoonful of common salt to the water nsed for sponging, as entirely removes all risk of cold as if sea water was employed, and after wiping, a coarse towel may be substituted for slight friction, to dry and cleanse the skin, if other means are not at hand. The nse of the hair gloves, however, I strongly recommend from experience, and the benefit I have derived from them myself. In the use of the bath, cold water is to

e preferred, which, with the addition of a little salt, becomes most agreeable excitant as well as tonic. It must not owever, be persevered in to the introduction of chilliness, r it will give the bather cold.

As to articles of dress, sufficient clothing to maintain a com- rtable degree of warmth is absolutely necessary to preserve ealth. This clothing, of course, must vary much, according the age, constitution, and activity of the individual. Without tivity, we none of us can expect either to be warm or healthy. n our changeable climate, flannel garments should always be orn next the skin, to protect it from the changes of tempe- ture we are all exposed to. Such should be frequently anged and aired. Concerning exercise, the physiologist sually speaks when treating of the muscles, which grow d increase by use, in size, firmness, and power; we ust, however, be content to make a few observations this subject here, not having time to treat further on the uscles themselves, than we have already done in our last cture. Regular exercise, employing all the limbs in its rvice two or three hours every day at least, is necessary for aintaining the healthy action of the skin, both with regard temperature and perspiration. By this means, the velocity the blood is increased in its vessels, and all the functions the body receive fresh vigour. To derive full benefit from ercise, however, it must be performed in the open air. hether as walking, riding, rowing, dancing, or by other des, exercise in the air, a certain portion of every day, ist be performed.

The diseases of the skin are the various cutaneous ptions mentioned in my last lecture, some of which are pposed to arise from an impure state of the blood, some m nervous sympathy with the stomach and bowels, whose cous coats are a continuation of the skin, and some from ernal sources, as want of cleanliness. The burning hot l perspireless state which attends fever generally, and the d and clammy states consequent on weak and languid culation, are also diseased states of this organ, and some- es induce a condition difficult to cure, even when the stitutional causes are removed. After fevers, the cuticle n separates and peels off, leaving the skin very delicate susceptible, and often disposed to dropsical effusions.

Suddenly checking the perspiration does not seem particularly injurious to the skin, but is dangerous to the internal organs, especially the bowels and the lungs, each of which also secrete from their vessels, watery fluids. These, in diarrhea from checked perspiration, are considerably increased. In cold weather, the condensation of the breath, plainly shews the copious evolution of such fluids from the lungs.

Here we must conclude our observations on the organs of growth and production, which may be called the *vegetable* system of our bodies, constituting the vital circle of assimilation, circulation, and waste; and I hope, by means of general views on former occasions, and various additional particulars now added, I have been enabled to afford somewhat both of information and intellectual gratification in this great branch of our subject. With a few further particulars concerning the organs peculiar to sensation, and essentially *animal*, namely, the nervous system, I shall conclude our present lecture, and this short course. And here I must restrict myself, (in anatomical detail at least,) to the brain, making our previous observations suffice for the organs of sense, the muscles, and the nerves.

The brain is a soft pulpy substance, enveloped in three distinct membranes, and filling the entire cavity of the skull, which according to phrenologists, although hard and osseous, always forms itself in accomodation to its softer contents. It thus occupies a space, reaching from the line of the eyes and ears, to the summit of the head, and is of a hemispherical form. Externally viewed, the brain on its upper surfaces is a series of convolutions, and beneath, or on its base, it receives the spinal cord, and nine pairs of nerves, which are called the cerebral nerves, and which pass off through perforations in the skull to the organs of sense, and are also otherwise distributed. On the summit, the whole organ splits down some considerable way into its interior, the membrane following the slit, and dividing it into two equal halves, each of which is called an hemisphere; and behind, a large lobe is further divided from it, called the cerebellum. The mass of the brain is called the cerebrum.

On cutting the cerebrum into two, by means of an horizontal section, we find a very curious structure opened to us.

The whole centre of the mass is white, and apparently fibrous, to within an inch or so of the edge, where it becomes of a reddish brown, and of a decidedly fibrous consistence, forming a dark circle around the entire brain in the form of a festoon or scollop. Of these substances, the white and softer is distinguished as the medullary, the other as the cortical part. In the centre of the white mass thus exposed, we perceive two large but shallow depressions or cavities, which, before the brain was sliced, formed close sacs or cells. These are called ventricles. They are somewhat oblong, dipping down in their corners in horn-like appendages, and almost fantastic shapes. The celebrated pineal gland, once considered by Descartes and others, as the peculiar seat of the soul, is a small protuberance situate on the base of the brain; its use is not known, nor in fact, are the purposes of any one particular part of the internal structure of this wonderful organ with any certainty ascertained. In dividing the cerebellum, we find the cortical and medullary substances arranged so as to present all the appearances of a white tree in the centre, which is accordingly called arbor vitæ. The cortical part here is greyer in colour than in the cerebrum, and hence is often called cineritious substance. The spinal cord is also composed of two similar substances. The spinal cord gives off thirty pairs of nerves, each nerve arising from it by two roots, one posterior, and the other anterior of the cord. The posterior root is further furnished by a ganglion. These nerves divide into numerous branches, and are distributed to all parts of the body.

To assign a mechanical or chemical function to the brain, may be thought presuming on my part, seeing that it is almost universally declared that we are in total ignorance concerning its physical uses. Therefore, I shall here express myself as merely offering an opinion, in addition and confirmation of my previous observations on this subject.

Contemplating the cerebrum, I first behold a nearly spherical organ, in the centre of which are two cavities, corresponding with the ventricles of the heart, with which latter organ the brain is now known to pulsate; and further, I discover that the ventricles of the brain are constantly bedewed with moisture, and through each of them runs a most exquisite and delicate chain of blood vessels.

These vessels, I look upon as the secreting organs of this moisture, which I conceive is distributed, as a fine fluid, throughout the whole nervous substance, by means of the pulsations of the ventricles. Thus circulated, I imagine this fluid, (which in conformity with the nomenclature of the ancients, I shall call animal spirits,) to be the peculiar residence of the nervous vitalities, similarly as the blood is the residence of the organic; and it is by means of physical impressions made on this fluid, through the external nerve being impressed, and its consequent oscillations and vibrations, that I conceive spiritual volitions are induced, answering to such movements; each of such volitions being one of those vital sensations or perceptive faculties which constitute corporeal sense. In the sympathetic or organic nerves, similar functions as those performed by the ventricles, may also be performed by the ganglions; so also, in animals, where the brain is wanted, some leading ganglion may supply the place of a brain. However, where a brain is present, I cannot but suppose all the nerves, both of sensation and motion, are in direct physical communion with it. This I think sufficiently obvious from the fact, that injury done to any part of the nervous system, paralyzes all parts which such injury severs from the brain. Recent opinions to the contrary, I have not seen in any way substantiated. The discovery, made by Tiedemann, that the brain in the fœtus is formed after the spinal cord and other nervous parts, analagous with the fact universal to comparative anatomy, that the perfect brain is never formed but in the most perfect class of animals, only shews that the inferior organs are first formed, and cannot prove when superior crowning organs are added to enable inferior ones to sustain the functions for which they are intended, that such inferior parts are independent, because first created.

Bearing this theory in mind we can thus account for the influences the state of the blood and the circulation have upon the nerves and the brain. How in jaundice and other diseased states of the blood, the nerves, by reason of the fluid they thence derive, must be affected. We can also shew how the nerves in their turn act on the blood, by constantly demanding its finest secretions, and exhausting it by continual volitions; and thus we may suppose the system is brought

into a state of collapse during sleep, when the heart beats faintly, and all its operations are slowly carried on. Thus we can account for paralysis, by conceiving obstructions in the way of the secreted fluid; and a union of the nervous fluid with the blood of the muscle may be considered as the proximate cause of muscular contraction, swelling its fibre, and so shortening its length; the vitality of the muscle, when roused, governing and directing in the result.

In conclusion, the phenomenon of sleep demands a few words in this place, before we part. When darkness covers the face of the earth, and a still solemn silence reigns around, God, in his infinite wisdom, has appointed us an hour of rest. The monstrous inconsistency of spiritual activity when all without is dark and obscure, forms no part of the divine economy of our creation. The habit of turning night into day, so common in the upper walks of society, is in every way reprehensible—injurious to health, and all the best interests of man. The morning sun, like the spring-time of the year, prepares us for the heat and labour of the day—it invigorates as no other time invigorates. The man who leaves his bed at noon, is not fitted to bear the noon-day influences; he has not advanced in power with the growing day, but is oppressed; and if he is weak, nervous, and miserable, let him not wonder at the cause, or make complaint, but let him break through his pernicious habits, and take his seven or eight hours' sleep before the early sun is up, and he will find balm in the morning air, to soothe and heal all his maladies.

My friends, I have finished; and taking my leave, permit me, again and again, to press these subjects upon your consideration, that, Physiology may receive its due at your hands. In giving it your chief attention, you will seek your own and each other's best interests, and discover, I was no enthusiast, when I stated, as my belief, that physiology, like a goddess, held in her rich and ample lap, blessings beyond count for all—scarcely imagined, almost inexpressible!*

* Lect. 1. page 16.

FINIS.

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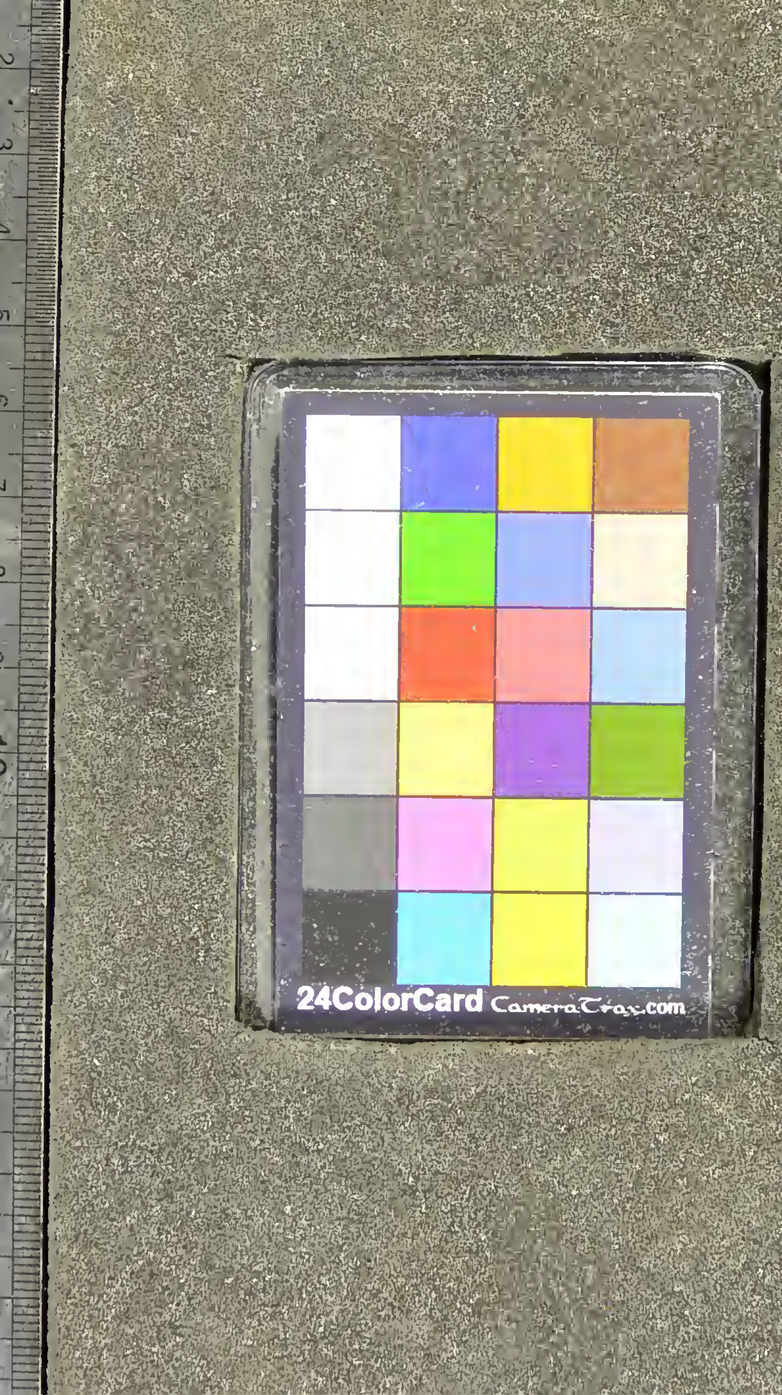
Dr. Craigie

with J. Bryce's

kind regards.

Mount Vernon

Aug. 1881.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